Lloyd's Register

Rules and Regulations for the Classification of Ships, July 2007

Notice No. 4

Effective Date of Latest Amendments:

See page 1

Issue date: April 2008

RULES AND REGULATIONS FOR THE CLASSIFICATION OF SHIPS, *July 2007*

Notice No. 4

This Notice contains amendments within the following Sections of the *Rules and Regulations for the Classification of Ships, July 2007.* The amendments are effective on the dates shown:

Part	*Chapter*	*Section*	*Effective date*
3	1	6, 8	1 July 2008
3	2	1	Corrigendum
3	8	5	Corrigenda
3	10	1, 2, 5	Corrigendum
3	11	8	1 July 2008
3	11	2	Corrigenda
3	13	2	Corrigendum
3	15	5	Corrigenda
4	1	1	1 July 2008
4	2	1, 2	1 July 2008
4	3	1	1 July 2008
4	3	9	Corrigenda
4	4	1, 2, 3, 4, 6, 7, 9, 10	1 July 2008
4	4	8	Corrigendum
4	7	9	Corrigendum
4	8	12	1 July 2008
5	1	3, 5	1 July 2008
5	2	4, 5, 13, 14	1 July 2008
5	4	1	Corrigendum
5	6	3	1 July 2008
5	8	1, 2, 4, 5	1 July 2008
5	10	15	1 January 2008
5	12	8	1 July 2008
5	13	1, 6, 8	1 July 2008
5	14	2	1 July 2008
5	15	1, 2	1 July 2008
5	19	9	1 July 2008
5	23	1, 2, 5, 6, 8	1 July 2008
5	23	6, 10	Corrigendum
6	1	3, 7	1 July 2008
6	2	1, 3, 4, 5, 6, 7, 8, 10, 11, 13, 14, 16, 18	1 July 2008
7	4	1, 2, 3, 4, 7	1 January 2008
7	5	1, 2, 3, 4	1 July 2008
7	9	1, 3, 5, 6	1 July 2008
7	11	2	1 July 2008
7	13	1	1 July 2008
7	15	Whole Chapter	1 July 2008
7	16	Whole Chapter	1 July 2008

It will be noted that the amendments also include corrigenda, which are effective from the date of this Notice.

The *Rules and Regulations for the Classification of Ships, July 2007* are to be read in conjunction with this Notice No. 4. The status of the Rules is now:

Rules for Ships	Effective date:	July 2007
Notice No. 1	Effective dates:	1 August 2007, 1 January 2008 & Corrigenda
Notice No. 2	Effective dates:	1 July 2007, 1 October 2007, 1 January 2008 & July 2008
Notice No. 3	Effective dates:	1 March 2008 & Corrigenda
Notice No. 4	Effective dates:	1 January 2008, July 2008 & Corrigenda

Part 3, Chapter 1
General

Effective date 1 July 2008

■ *Section 6*
Definitions

6.1 Principal particulars

6.1.1 Rule length, *L*, is the distance, in metres, on the summer load waterline from the forward side of the stem to the after side of the rudder post or to the centre of the rudder stock if there is no rudder post. *L* is to be not less than 96 per cent, and need not be greater than 97 per cent, of the extreme length on the summer load waterline. For ships without rudders, the Rule length is to be taken as 97 per cent of the extreme length on the summer load waterline. In ships with unusual stem or stern arrangements the Rule length, *L*, will be specially considered.

■ *Section 8*
Inspection, workmanship and testing procedures

8.3 Testing procedures

(*Part only shown*)

Table 1.8.1 Testing requirements

Item to be tested	Testing procedure	Testing requirement
Watertight bulkheads, shaft tunnels, flats and recesses, etc.	Hose (2)	*See* 8.3.5
Watertight doors (below freeboard or bulkhead deck) when fitted in place	Hose (9)	
Weathertight hatch covers and closing appliances	Hose	
Fore peak not used as tank	Hose (2)	
Shell doors when fitted in place	Hose (13)	

NOTES
1. Leak or hydropneumatic testing may be accepted, provided that at least one tank of each of structural configuration is structurally tested, to be selected in connection with the approval of the design. For chemical tankers, all cargo tank boundaries are to be structurally tested from at least one side, *see also* 8.3.8.
2. When hose testing cannot be performed without damaging possible outfittings already installed, it may be replaced by a careful visual inspection of all the crossings and welded joints. Where necessary, dye penetrant test or ultrasonic leak test may be required.
3. Testing of the aft peak is to be carried out after the sterntube has been fitted.
4. The highest point of the tank is generally to exclude hatchways. In holds for liquid cargo or ballast with large hatch openings, the highest point of the tank is to be taken to the top of the hatch.
5. If leak or hydropneumatic testing is carried out, arrangements are to be made to ensure that no pressure in excess of 0,30 bar (0,30 kgf/cm^2) can be applied.
6. A minimum of every second hatch cover is to be tested.
7. To be carefully examined with the vessel afloat.
8. Alternative methods of testing will be considered.
9. *See also* SOLAS Reg. II-1/18. Where the door has had the full hydrostatic test before installation, the hose test may be replaced by careful visual examination after full operational tests.
10. Pressure/vacuum relief valve head to be taken as 12,0 p_V m above the top of the tanks, where p_V is the maximum positive pressure/vacuum relief valve setting, in bar (kgf/cm^2).
11. Prior to performing the test, small access hatches having a smaller coaming height than the main hatch are to be fully closed.
12. For those designs unable to apply the tank test requirements up to the top of the hatch coaming, the applied head is to be as close to the hatch coaming top level as is reasonably practical.
13. For shell doors providing watertight closure, watertightness is to be demonstrated through prototype testing before installation. Testing procedure to be agreed with LR.

Part 3, Chapter 2
Materials

CORRIGENDUM

■ *Section 1*
Materials of construction

1.2 Steel

(*Part only shown*)

Table 2.1.1 Values of k_L

NOTES
1. Intermediate values by linear interpolation.
2. For the purpose of calculating hull moment of inertia as specified in ~~Ch 4,5.7.1~~ Ch 4,5.8.1, k_L = 1,0.

Part 3, Chapter 8
Superstructures, Deckhouses and Bulwarks

CORRIGENDA

■ *Section 5*
Bulwarks, guard rails and other means for the protection of crew

5.3 Freeing arrangements

(*Part only shown*)

5.3.22 In ships having superstructures which are open at either or both ends to wells formed by bulwarks on the open deck, adequate provision for freeing the open spaces are to be provided as follows:

A_c = bulwark height correction factor taken as;
= 0 for bulwarks between 0,9 and 1,2 m in height
= $l_w \left(\frac{(h_b - 1,2)}{\text{~~1,0~~ } 0,1} \right)$ (0,004) m^2 for bulwarks of height greater than 1,2 m, and
= $l_w \left(\frac{(h_b - 0,9)}{\text{~~1,0~~ } 0,1} \right)$ (0,004) m^2 for bulwarks of height less than 0,9 m

Part 3, Chapter 10
Welding and Structural Details

CORRIGENDUM

■ *Section 1*
General

1.1 Application

1.1.3 The requirements in this Chapter are not applicable to Double Hull Oil Tankers or Bulk Carriers with a CSR notation (*see* Pt 1, Ch 2,2.3) with the exception of ~~2.9 to 2.13~~ 2.5 to 2.9 which are to be complied with.

■ *Section 2*
Welding

2.6 Fillet welds

(*Part only shown*)

Table 10.2.1 Weld factors (*see continuation*)

Item	Weld factor	Remarks
(6) Structure in cargo oil tanks of tankers (*see* 1.1.3):		
Bottom longitudinals to shell	0,21	for forward of 0,3*L*
Longitudinal of flat-bar type to plating		*see* ~~2.6.7~~ 2.2.5
NOTES 5. The throat thickness of the weld is to be determined by ~~2.6.7~~ 2.2.5. For longitudinals within *D*/4 of the strength deck and with a thickness less than 100 mm, the throat thickness need not exceed 5,5 mm.		

2.9 Welding equipment

(*Part only shown*)

Table 10.2.5 Weld connection of strength deck plating to sheerstrake

Item	Stringer plate thickness, mm	Weld type
NOTES 2. *See also* ~~2.6.11~~ 2.2.8.		

2.13 Inspection of welds

(*Part only shown*)

Table 10.2.6 Non-destructive examination of welds

Volumetric non-destructive examinations – Recommended extent of testing, *see* ~~2.13.15~~ 2.9.3

■ *Section 5*
Structural details

5.2 Arrangements at intersections of continuous secondary and primary members

5.2.11 In general where the primary member stiffener is connected to the secondary member it is to be aligned with the web of the secondary member, except where the face plate of the latter is offset and abutted to the web, in which case the stiffener connection is to be lapped. Lapped connections of primary member stiffeners to mild steel bulb plate or rolled angle secondary members may also be permitted. Where such lapped connections are fitted, particular care is to be taken to ensure that the primary member stiffener wrap around weld connection is free from undercut and notches, *see also* ~~2.13~~ 2.9.

Part 3, Chapter 11

Closing Arrangements for Shell, Deck and Bulkheads

CORRIGENDA

■ *Section 2* Steel hatch covers

2.2 Webs and stiffeners

2.2.5 On ships of length L_L greater than 100 m, hatch covers fitted on top of a second, or virtual second, tier superstructure (as defined in Ch 8,1.3) or above, may be permitted a reduction in design pressure. The following minimum scantlings are to be complied with:

(a) Abaft 0,25L_L the cover plate thickness may be 0,0091s but not less than 6 mm.

(b) The value of ~~h_H~~ p used in 1.2.1 may be 25,5 kN/m^2 forward of 0,25L_L, and 20,6 kN/m^2 abaft of 0,25L_L.

Effective date 1 July 2008

■ *Section 8* Side and stern doors and other openings

8.2 General

8.2.6 Watertight doors below the freeboard deck, with the exception of pilot doors which are to open inwards, are to open outwards. Weathertight doors ~~Doors~~ are generally to be arranged to open outwards, however inward opening doors will be considered provided these satisfy the requirements of 8.2.7.

Part 3, Chapter 13

Ship Control Systems

CORRIGENDUM

■ *Section 2* Rudders

2.2 Rudder torque calculation for rudders without cut-outs

2.2.1 The rudder torque, M_T, is to be determined for both the ahead and astern conditions according to the following formula:

$$M_T = P_L x_P \quad \text{Nm}$$

where

P_L = lateral force acting on rudder, as calculated in 2.1

x_P = $b_R(\alpha - k)$, in metres, but not less than $0{,}1b_R$

M_T = the rudder torque, in Nm, to be calculated for both ahead and astern conditions. The greater of these two values are to be used throughout Section 2

b_R = mean breadth of rudder, in metres, *see* Fig. 13.2.2

α = as given in Table 13.2.2

$$k = \frac{A_f}{A_R}$$

Part 3, Chapter 15

Quality Assurance Scheme for the Hull Construction of Ships

CORRIGENDA

■ *Section 5*

Additional requirements for Part 2 of the Scheme

5.2 Quality Plans

5.2.1 Quality Plans for ships which are to be classed by LR are to be submitted for approval well in advance of commencement of work, irrespective of any submissions that may have been made for sister ships under Part 1 of the Scheme. Such Quality Plans are to outline all of the manufacturing, testing and inspection operations to be performed by the Shipbuilder and by which personnel they will be carried out. The Quality Plans are then to be submitted to the LR Surveyors who will indicate all the stages at which they will perform system monitoring, carry out direct inspection and participate in hold point inspections. These hold points will include, but not be limited to, the following:

(a) Radiographs and other test records of non-destructive examinations as required for Classification purposes, *see* ~~Ch 10,2.13~~ Ch 10,2.9.

(b) The items described in Ch 1,8 relevant to the scope of this Chapter.

Part 4, Chapter 1

General Cargo Ships

Effective date 1 July 2008

■ *Section 1*

General

1.3 Class notations

1.3.3 The following additional notations and annotations can be appended to the main class notation giving further detailed description of the loading criteria incorporated into the design:

(a) **RD** (Relative density):
Where a ship has tanks appraised for a maximum permissible relative density greater than 1,025, the notation **RD(specified tank names, density)** may be added.

(b) **WDL(+)** (Weather deck load):
The notation **WDL(+)** may be added. If requested, the maximum permissible weather deck load and extent can be identified in the notation, e.g. **WDL(5,0 t/m^2 from Aft to Fr. 26)**.

Existing paragraphs 1.3.3 *and* 1.3.4 *are to be renumbered* 1.3.4 *and* 1.3.5.

Part 4, Chapter 2
Ferries, Roll on-Roll off Ships and Passenger Ships

Effective date 1 July 2008

■ *Section 1* General

1.3 Class notations

1.3.1 In general, ships complying with the requirements of this Chapter will be eligible to be classed:

'**100A1 passenger ferry**', or
'**100A1 passenger/vehicle ferry**', or
'**100A1 roll on-roll off cargo ship**', or
'**100A1 vehicle carrier**', or
'**100A1 passenger ship**', or
'**100A1 sailing passenger ship**'.

■ *Section 2* Longitudinal strength

2.5 Design wave shear force

2.5.1 The design vertical wave shear force, Q_w, at any position along the ship is given by:

$Q_w = 3f_1 K_f M_{wo}/L$ kN (tonne-f)

where

K_f is to be taken as follows, *see also* Fig. 2.2.2:

(a) Positive shear force:
- K_f = 0 at aft end of L
- = $+0{,}836f_{fH}$ between 0,2L and 0,3L from aft
- = $+0{,}65f_{fH}$ between 0,4L and 0,5L from aft, but not to be less than 0,70
- = $-0{,}65f_{fS}$ between 0,5L and 0,6L from aft
- = $-0{,}91f_{fS}$ between 0,7L and 0,85L from aft
- = 0 at forward end of L

(b) Negative shear force:
- K_f = 0 at aft end of L
- = $+0{,}836f_{fS}$ between 0,15L and 0,3L from aft
- = $+0{,}65f_{fS}$ between 0,4L and 0,5L from aft
- = $-0{,}65f_{fH}$ between 0,5L and 0,6L from aft, but not to be greater than –0,70
- = $-0{,}91f_{fH}$ between 0,7L and 0,85L from aft
- = 0 at forward end of L

Intermediate values to be determined by linear interpolation.

f_1, M_{wo}, f_{fS} and f_{fH} are defined in 2.4.1.

Part 4, Chapter 3
Tugs

Effective date 1 July 2008

■ *Section 1* General

1.2 Class notations

~~*1.2.1* In general, tugs for unrestricted service complying with the requirements of Sections 1 to 8 will be eligible to be classed **100A1 tug.**~~

~~*1.2.2* Tugs for unrestricted service complying with the requirements of this Chapter, except 9.3, will be eligible to be classed **100A1 escort tug.**~~

~~*1.2.3* Tugs for unrestricted service complying with the requirements of this Chapter will be eligible to be classed **100A1 escort tug EPN (F,B,V,C).** The performance numeral **(F,B,V,C)** contains the performance ratings obtained from full scale trials in accordance with 9.3.~~

1.2.1 Ships complying with relevant requirements will be assigned one or more of the class notations given in Table 3.1.1.

Existing paragraphs 1.2.4 *and* 1.2.5 *are to be renumbered* 1.2.2 *and* 1.2.3.

Table 3.1.1 Class notations

Class Notation	Applicable Sections
100A1 tug	Sections 1 to 8
100A1 escort tug	Sections 1 to 9, except 9.3
100A1 escort tug EPN (F,B,V,C)	Sections 1 to 9
NOTE Tugs which comply with the anchor handler requirements in Ch 4, Sections 1 to 4 and 10 will be eligible for the additional notation **anchor handler.**	

CORRIGENDA

■ *Section 9*
Escort operation, performance numeral and trials

9.3 Performance trials

9.3.1 Escort tugs which carry out full scale performance trials in accordance with the requirements of this Section will be eligible to have the escort performance numeral **EPN (F,B,V,C)** appended to the **escort tug** notations, *see* ~~1.2.3, 1.2.4~~ 1.2.1 and 1.2.2 and Ch 4,1.2.2,

where

F is the maximum steering force (F_s), in tonnes, *see* Fig. 3.9.1 and 9.3.6.

B is the maximum braking force (F_b), in tonnes, *see* Fig. 3.9.1 and 9.3.6.

V is the speed, in knots, at which **F** and **B** are determined.

C is the time, in seconds (s), required for the escort tug in manoeuvring from maintained oblique position of tug giving maximum steering force F_s on one side of assisted vessel to mirror position on the other side, *see* 9.3.6. The towline angle, α, need not be taken less than 30°, *see* Fig. 3.9.1.

Part 4, Chapter 4
Offshore Supply Ships

Effective date 1 July 2008

■ *Section 1*
General

1.2 Class notations

1.2.1 In general, ships complying with the requirements of this Chapter and relevant additional requirements will be eligible ~~to be classed:~~ for one or a combination of the notations indicated in Table 4.1.1.

- ~~**100A1 offshore supply ship**; or~~
- ~~**100A1 offshore tug/supply ship**;~~

~~whichever is applicable.~~

~~*1.2.2* Ships complying with the requirements of Ch 3,9 and the requirements of this Chapter will be eligible to be classed:~~

- ~~**100A1 offshore escort tug/supply ship**; or~~
- ~~**100A1 offshore escort tug EPN (F,B,V,C)/supply ship**;~~

~~whichever is applicable.~~

Table 4.1.1 Class notations applicable to Offshore Supply Ships

Class notation	Requirements
100A1	Pt 1, Ch 2
Offshore supply ship	Pt 4, Ch 4, Sections 1 to 7
Standby ship	Pt 4, Ch 4, Sections 1 to 7 and 9
Anchor handler	Pt 4, Ch 4, Sections 1 to 7 and 10 Sections 5 to 7 need not be applied if notation for **Offshore supply ship** is not applied
Tug **Escort tug** **Escort tug EPN (F,B,V,C);**	Pt 4, Ch 3, Sections 1 to 8 Pt 4, Ch 3, except 9.3 Pt 4, Ch 3
Oil Recovery	Pt 7, Ch 5

NOTE
A ship designed to fulfil more than one function can be assigned a combination of the notations listed above, e.g.:
- **100A1 Offshore supply ship/Standby ship**
- **100A1 Offshore supply ship/Anchor handler**
- **100A1 Offshore supply ship/Standby ship/Oil Recovery**
- Any combination of the requirements listed in this table.

1.2.2 The following additional notations and annotations can be provided to give a further detailed description of features:

- **WDL(+)** (Weather deck load):
  If the weather deck scantlings have been approved for a loading greater than a design head of 3,5 m, the notation **WDL(+)** may be added. If requested, the maximum permissible weather deck load and extent can be identified in the notation, e.g. **WDL(5,0 t/m^2 from Aft to Fr. 26)**.
- **RD** (Relative density):
  Where a ship has tanks appraised for a maximum permissible relative density greater than 1,025, the notation **RD(specified tank names, density)** may be added, *see* Chapter 1.
- **LFPL** (Low flashpoint liquids):
  Ships intended for the carriage of liquids with flash point below 60°C (closed cup test) in bulk are to be built and equipped in accordance with the relevant requirements of Section 8 and will be given the class notation **LFPL**. If requested, the concerned cargo, flash point (closed cup test) and tank can be identified in the notation, e.g. LFPL(methanol, 12°C, No. 7 centre tank).

1.3 Information required

1.3.1 In addition to the information and plans required by Pt 3, Ch 1,5, plans covering the following items are to be submitted where applicable:

- ~~Separate or independent~~ Independent cargo tanks.
- Cargo tank foundations and securing arrangements.
- Towing arrangements, including supports and foundations of towing winches.
- ~~Supports and foundations for anchor handling and laying arrangements for anchors carried as cargo.~~
- Arrangements for the stowage of deck cargoes (cargo containment) and details of any associated racks or other similar structures and their supports/foundations ~~and foundations~~ together with information to indicate design loads.
- Movable decks, including the stowing arrangements for portable components.
- Freeing arrangements.

■ *Section 2* Longitudinal strength

2.1 General

2.1.2 The requirements of Pt 3, Ch 4,8.3 regarding loading instruments are generally not applicable to offshore supply ships.

■ *Section 3* Hull envelope plating

3.1 Side shell

3.1.1 The thickness of side shell is to be that required by Ch 1,5.4 but is not to be less than given by Table 4.3.1 ~~in no case to be less than 9 mm~~.

Table 4.3.1 Minimum side shell thickness

Ship type	Minimum thickness, mm
Offshore supply ships	9
Standby ships	8
Anchor handler	9

3.1.2 ~~Efficient fenders are to be fitted, with adequate support behind them, in exposed areas.~~ As an alternative, where over the length of a vessel, portions of the sheer strake that are not protected by an efficient fender, the sheer strake is to be increased by a minimum of 5 mm thickness. The increased thickness shall extend from the deck level to not less than 600 mm below the deck level.

~~*3.1.3* Shell in way of stern rollers immediately adjacent to high duty bollards and in other high load areas is to be suitably reinforced.~~

3.2 Weather decks

3.2.1 Where cargo is to be carried on weather decks, the scantlings are to be suitable for the specified loadings~~, but in no case is a head less than 3,5 m to be used. Additional local increases in scantlings may be required where specialized cargoes are likely to induce concentrated loads.~~ The thickness, t, of deck plating is to be not less than the greater of:

~~$t = (0{,}025L + 7)$ mm~~

(a) $t = 0{,}025L + 4{,}5 + t_a$ mm

(b) $t = 0{,}1 f_m s \sqrt{\dfrac{P F_D}{f_y \sigma}} + t_a$ mm

where

P = specified design load for weather deck, in tonnef/m^2

$= \dfrac{h}{1{,}39}$

h = equivalent design head, in metres, not to be taken less than 3,5 m

s = spacing of secondary stiffeners, in mm

σ = yield stress of plating, in N/mm^2

F_D = as defined in Pt 3, Ch 4,5.7

f_m = 0,75

f_y = 0,67

t_a = 2,5 mm, in general

= 1,0 mm, for ships with dedicated class notation **Standby ship**.

3.2.2 Scantlings are to be increased locally where specialized cargoes are likely to induce concentrated loads that exceed the specified design load. Acceptable stress levels are given in Ch 3,7.2.4.

■ *Section 4*
Hull envelope framing

4.1 ~~Transverse framing~~ General

4.1.1 The section moduli of side longitudinals, the main and 'tween deck frames are to be not less than kZ, cm^3 ~~25 per cent greater than those required by Ch 1,6, Pt 3, Ch 5,4 and Pt 3, Ch 6,4. Frames are not to be scalloped.~~

where

k = 1,25 in general

= 1,10 for ships with dedicated class notation **Standby ship**

Z = as required by Ch 1,6, Pt 3, Ch 5,4 and Pt 3, Ch 6,4 for the appropriate location.

4.1.2 Frames are not to be scalloped.

4.1.3 The scantlings of deck secondary stiffeners are to be in accordance with the requirements of Table 1.4.4(1) or Table 1.4.5(2) in Pt 4, Ch 1, where h_2 is to be taken as the specified design loading and not less than a design head of 3,5 m.

■ *Section 6*
Miscellaneous openings

6.3 Windows and side scuttles

~~*6.3.11*~~ *6.3.9* For the location of windows and side scuttles, *see* Fig. 4.6.1.

~~*6.3.9*~~ *6.3.10* The thickness of the toughened safety glass for windows is to be ~~determined from Tables 4.6.1 and 4.6.2.~~ not less than the greater of:

(a) $t = 10$ mm

(b) $t = b \sqrt{\dfrac{H_d \beta}{4000}}$ mm

where

H_d = design pressure head, in metres, as obtained from Table 4.6.1

b = length of shorter side of window, in mm

β = $0{,}54A_R - 0{,}078A_R^2 - 0{,}17$ for $A_R \le 3$

= 0,75 for $A_R > 3$

A_R = aspect ratio of window

= a/b

a = length of longer side of window, in mm.

6.3.11 Proposals for alternative materials will be specially considered.

~~*6.3.10*~~ *6.3.12* ~~Windows of larger sizes than given in Tables 4.6.1 and 4.6.2~~ On standby ships, windows larger than 1000 x 710 or an area greater than 0,71 m^2 are not acceptable, except in the after ends of deckhouses which are to be submitted for consideration in each case.

~~**Table 4.6.1**~~ **Thickness of toughened safety glass fitted in windows in front and side bulkheads**

Nominal dimensions of window, mm x mm	Thickness of toughened safety glass, mm			
	2nd tier	3rd tier	4th tier	5th tier
300 x 425	12	12	10	10
355 x 500	15	15	12	10
400 x 560	19	15	12	10
450 x 630	19	19	15	12
500 x 710	–	19	15	12
560 x 800	–	–	19	15
900 x 630	–	–	–	15
1000 x 710	–	–	–	19

~~**Table 4.6.2 Thickness of toughened safety glass fitted in windows in after end bulkheads**~~

Nominal dimensions of window, mm x mm	Thickness of toughened safety glass, mm		
	2nd tier	3rd tier	4th tier and higher
300 x 425	10	10	10
355 x 500	10	10	10
400 x 560	12	12	10
450 x 630	15	12	10
500 x 710	15	15	10
560 x 800	–	15	10
900 x 630	–	19	12
1000 x 710	–	–	12

Table 4.6.1 Design pressure head, H_d, on windows

	Design pressure head, in metres	
	Windows in front and side bulkheads	Windows in after end bulkheads
6th tier and above	3,0	2,5
5th tier	5,0	2,5
4th tier	8,0	2,5
3rd tier	12,5	6,25
2nd tier	14,0	8,0

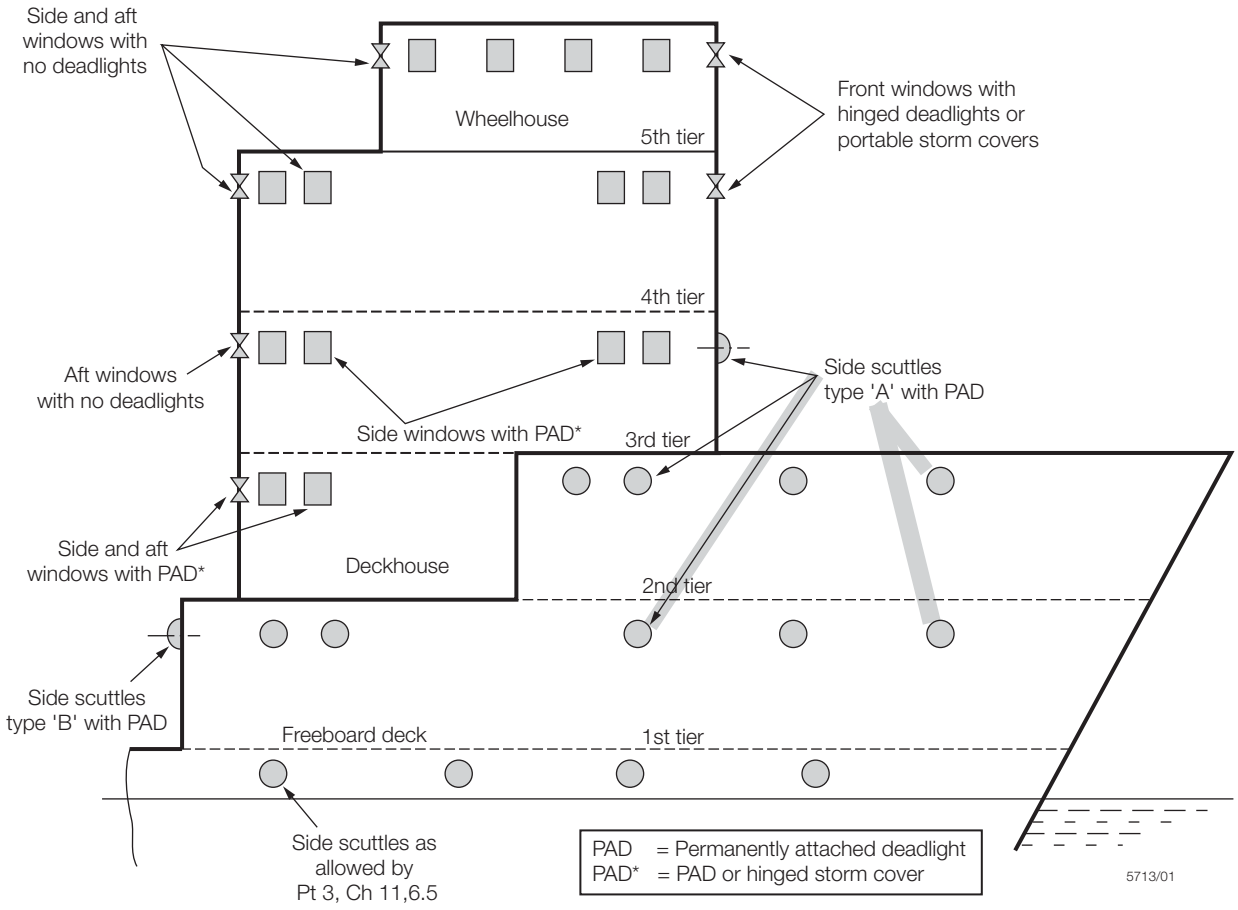

Fig. 4.6.1 Location of windows and side scuttles

~~*Section 7*~~
~~Watertight bulkhead doors~~

~~7.1 Watertight doors~~

~~*7.1.1* Watertight doors are to be efficiently constructed and fitted in accordance with Pt 3, Ch 11,9 and hose tested in place as required by Pt 3, Ch 1,8.~~

Section 8 7
Engine exhaust outlets

~~8.1~~ 7.1 Location

~~*8.1.1*~~ *7.1.1* Engine exhaust outlets are to be located as high as is practicable above the deck and are to be fitted with spark arresters.

CORRIGENDA

Section 8
Transport and handling of limited amounts of hazardous and noxious liquid substances in bulk

8.1 General

(Part only shown)

8.1.3 Products which may be carried are:

(b) flammable liquids (liquids having a flashpoint not exceeding ~~600~~ 60°C (closed cup test).

Effective date 1 July 2008

Section 9
Standby ship

9.1 Application and definitions

9.1.1 The requirements in this Section apply to standby ships. A standby ship is a seagoing ship designed, constructed, organised and maintained in such a way that she can give assistance in the event of an emergency on or near an offshore installation.

9.1.2 The National Authority with whom the ship is registered and/or the Administration within whose territorial jurisdiction the ship is intended to operate may have requirements for the same items as required by these Rules. In those instances the more onerous requirements are to be applied.

9.2 Configuration of standby ship

9.2.1 The main features of standby ships which dictate the structural configuration are:

(a) Designated and illuminated winching area for helicopter operations.
(b) Clearly marked and lighted rescue zone at the side of the ship.
(c) Survivors area.
(d) Fast rescue boat.

9.3 Information required

9.3.1 In addition to the information and plans required by Ch 4,1.3, details of local strengthening of the following items are to be submitted where applicable:

(a) The arrangement and integration into the hull of equipment, supports, foundations for rescue equipment, etc. in conjunction with their weight, working load and holding capability information.
(b) Support for towing arrangement as applicable.
(c) The arrangement for the fast rescue craft

9.4 Equipment foundations

9.4.1 When considering the loads, all expected directions of operation are to be taken into account.

9.4.2 The foundation for towing equipment, if applicable, is to be in accordance with Ch 3,7.2.

9.5 Ship Arrangement

9.5.1 For standby ships the rescue arrangement, accommodation and facilities for survivors and safety equipment is required to comply with a National Standard. The applicable Certificate or Statement of Compliance with a National Standard is to be issued by a National Administration, or by LR, or by an IACS member when so authorised. Where no national requirements exist for a particular vessel, LR will issue statement of compliance with UKOOA.

Section 10
Anchor handler

10.1 Application and definitions

10.1.1 The requirements of this Section apply to ships specially designed, constructed and equipped for handling anchors of a floating offshore installation.

10.2 Structural configuration

10.2.1 The main features of an anchor handler which dictate the structural configurations are:

(a) The ship has a completely clear after deck in order to handle the anchors effectively.
(b) One or more winches designed for the purpose of deploying and recovering the anchors.

(c) Large horizontal stern roller, if fitted. During the anchor-handling process the ship is often required to take the anchors on board by hauling them over her stern, along with their associated chain and other fittings. For this purpose a large horizontal roller is installed in the stern, usually at deck level.
(d) A rounded form in way of the area for shipping/unshipping anchors at stern.
(e) Chain lockers under the main winch, if fitted. Anchor handlers are sometimes required to store rig or mooring chain and, for this purpose, most are fitted with chain lockers under the main winch which double as ballast or brine tanks when not in use.
(f) Equipment for temporary securing of the anchor e.g. shark's jaw.
(g) Towing pins in way of the stern roller.
(h) High duty bollards.

10.3 Information required

10.3.1 In addition to the information and plans required by Ch 4,1.3, details of local strengthening of the following items are to be submitted where applicable:
(a) The arrangement and integration into the hull of equipment, tanks, supports, foundations, etc. in conjunction with their weight, working load and holding capability information.
(b) For unusual structural arrangement and equipment, calculations are to be submitted showing acceptable structural strength.
(c) Supports and foundations for anchor handling and laying arrangements for anchors carried as cargo.

10.4 Hull envelope plating

10.4.1 Anchor handing activities often give rise to areas of high local loads and/or frequent impacts, such as in way of stern rollers and immediately adjacent to high duty bollards. The shell in way of high loads and/or frequent impacts is to be suitably reinforced by increasing shell plate thickness, additional stiffening support or other appropriate means.

10.5 Working deck

10.5.1 Deck areas, where there are arrangements for the collection and handling of anchors and associated equipment, are to be protected by wooden sheathing. Alternatively, this can be omitted if the plate thickness is increased by 2,5 mm.

10.6 Equipment foundations

10.6.1 When considering the loads, all expected directions of operation are to be taken into account. The foundation for deck equipment (winch, stern roller etc.) is to be in accordance with Pt 4, Ch 3,7.2 as applicable.

Part 4, Chapter 7
Bulk Carriers

CORRIGENDUM

■ *Section 9*
Hopper side tank structure

9.3 Sloped bulkhead stiffeners

9.3.1 The scantlings of sloped bulkhead stiffeners are to be as required for inner bottom longitudinals, *see* Section 8. In ships strengthened for heavy cargoes, the scantlings of the stiffeners are to be derived from Table 7.8.1 using a head for heavy cargo measured vertically from the mid-point of the effective length to the underside of the topside tank sloped bulkhead. Where the hopper tanks are interconnected with the topside tanks, or in way of ballast holds, the scantlings of the stiffeners are also to comply with the requirements of Table 7.8.1(4)(c) and (4)(d), whichever is appropriate. For higher tensile steel longitudinals the requirements of ~~6.2.3~~ Pt 4, Ch 1,6.2.3 are to be complied with where applicable, *see also* 9.7.1.

Part 4, Chapter 8
Container Ships

Effective date 1 July 2008

■ *Section 12*
Strengthening for wave impact loads

12.1 General

12.1.1 The scantlings of plating, stiffeners ~~and primary structure~~ of forward and after portions of the hull are to be increased for protection against bow flare and wave impact pressure in accordance with Ch 2,4.3 and 5.2.

12.1.2 The scantlings of the primary support structure are to be adequate to resist the application of the Rule slamming load, P_{bf}, as defined in Ch 2,4.2.1, over an area A_{sl}, as shown in Fig. 2.5.2 in Chapter 2. The loaded area, A_{sl}, is a rectangle with a horizontal extent, g_{bfh}, and vertical extent, g_{bfv}, taken as follows:

g_{bfh} = 4 m

$$g_{bfv} = \frac{8}{\sin\beta_p \sqrt{8K_{bf}}} \text{ m}$$

where

K_{bf} and β_p are given in Ch 2,4.2.1

12.1.3 To satisfy 12.1.2, the scantlings of web frames supporting side longitudinals or side stringers supporting transverse frames are to comply with the following:

(a) Section modulus not to be less than:

$$Z = 3{,}75 f_{rpc}\, \gamma_Z\, k\, h_s\, q\, v\, l_e^2 \text{ cm}^3$$

(b) Web area not to be less than:

$$A = 0{,}20 f_{rpc}\, \gamma_A\, k\, h_s\, q\, v\, l_e \text{ cm}^2$$

where

h_s = wave impact head, in metres, as defined in Ch 2,4.3.2.

and

$$f_{rpc} = \frac{P}{3{,}05V^3}\left(\frac{P}{2{,}27V^3}\right)$$

P is the maximum propulsion shaft power in kW(HP) for which the machinery is classed, *see* Pt 5, Ch 1,3

V is the speed, in knots as defined in Pt 3, Ch 1,6

γ_A and γ_Z are strength factors dependent on the load position:

for $q < 1$: $\gamma_A = q^3 - 2q^2 + 2$ and $\gamma_Z = 3q^3 - 8q^2 + 6q$

for $q = 1$: $\gamma_A = 1\gamma_Z = 1$

$$q = \frac{u}{l_e} \text{ but} \le 1$$

for web frames

u is the minimum of g_{bfv} or l_e

v is the minimum of g_{bfh} or S_{cm}

for side stringers

u is the minimum of g_{bfh} or l_e

v is the minimum of g_{bfv} or S_{cm}

l_e is the effective length of the primary member, in metres

S_{cm} is the mean spacing between primary members along the plating, in metres, *see* Fig. 2.5.2 in Chapter 2

g_{bfv} and g_{bfh} are defined in 12.1.2

(c) Web plating is to be adequately stiffened to resist shear buckling as required by Table 8.12.1.

Table 8.12.1 Critical shear buckling stress for web plating of primary support structure

$\tau_A \le \tau_{CRB}$

where

$$\tau_{CRB} = \tau_E \text{ N/mm}^2 \text{ (kg-f/mm}^2\text{)} \quad \text{when } \tau_E \le \frac{\tau_0}{2}$$

$$\tau_{CRB} = \tau_0\left(1 - \frac{\tau_0}{4\tau_E}\right) \text{ N/mm}^2 \text{ (kg-f/mm}^2\text{)} \quad \text{when } \tau_E > \frac{\tau_0}{2}$$

where

$$\tau_E = 3{,}6\left[1{,}335 + \left(\frac{s}{1000s}\right)^2\right] E \left(\frac{\tau_p}{s}\right)^2 \text{ N/mm}^2 \text{ (kg-f/mm}^2\text{)}$$

Symbols

τ_A = design shear stress for the web panel in N/mm^2 (kgf/mm^2) corresponding to the worst combination of application of the slamming load P_{bf} on the patch area A_{sl}

τ_{CRB} = critical buckling stress in shear, N/mm^2 (kgf/mm^2) corrected for yielding effects

$$\tau_0 = \frac{\sigma_o}{\sqrt{3}}$$

σ_o = specified minimum yield stress, in N/mm^2 (kgf/mm^2)

τ_E = elastic critical buckling stress in shear, in N/mm^2 (kgf/mm^2)

s = length of longer panel edge, in mm (generally the spacing of web stiffeners)

S = length of smaller panel edge, in metres (generally the web depth)

E = modulus of elasticity, in N/mm^2 (kgf/mm^2)
= 206000 N/mm^2 (21000 kgf/mm^2) for steel

τ_p = as built thickness of primary member web plating, in mm

Part 5, Chapter 1
General Requirements for the Design and Construction of Machinery

Effective date 1 July 2008

■ *Section 3*
Operating conditions

3.6 Ambient operating conditions

3.6.2 Where it is intended to allow for operation in ambient temperatures outside those shown in Table 1.3.1, the permissible temperatures and associated periods of time are to be specified and details are to be submitted for consideration. Propelling and essential auxiliary machinery, *see* Pt 1, Ch 2,2.8.1, is to retain a continuous level of functional capability under these conditions and any level of degraded performance is to be defined. Operation under these circumstances is not to be the cause of damage to equipment in the system and is additionally to be acceptable to the National Authority of the country in which the ship is to be registered.

(*Part only shown*)

Table 1.3.1 Ambient operating conditions

Water	
Coolant	**Temperature (°C)**
Sea-water or charge air coolant inlet to charge air cooler	-2 to +32, *see* ~~Note 1~~ Notes 1 and 3
NOTES	
3. Charge air cooling arrangements utilising re-circulated cooling to maintain temperatures in a different range are accepted where the machinery and equipment operation is not degraded with a primary supply of cooling in the temperature range stated in this Table.	

■ *Section 5*
Trials

5.2 Sea trials

~~*5.2.5* The stopping times, ship headings and distances recorded on trials, together with the results of trials to determine the ability of ships having multiple propellers to navigate and manoeuvre with one or more propellers inoperative, are to be available on board for the use of the master or designated personnel.~~

5.2.5 The following information is to be available on board for the use of the master and designated personnel:

- The results of trials to determine stopping times, ship headings and distance;
- For ships having multiple propellers, the results of trials to determine the ability to navigate and manoeuvre with one or more propellers inoperative.

5.2.7 The stopping distance achieved when ship is initially proceeding ahead with a speed of at least 90 per cent of the ship's speed corresponding to 85 per cent of the maximum rated propulsion power should not exceed 15 ship lengths after the astern order has been given. However, if the displacement of the ship makes this criterion impracticable then in no case should the stopping distance exceed 20 ship lengths.

~~*5.2.7*~~ *5.2.8* All trials are to be to the Surveyor's satisfaction.

Part 5, Chapter 2
Oil Engines

Effective date 1 July 2008

■ *Section 4*
Construction and welded structures

4.4 Post-weld heat treatment

4.4.3 Omission of post-weld heat treatment of bedplates and their sub-assemblies will be considered on application by the engine builder with supporting evidence in accordance with Chapter 13,8.4 of the Rules for Materials.

■ *Section 5*
Safety arrangements on engines

5.3 Auxiliary engine governors

5.3.2 Emergency engines are to comply with 5.3.1 except that the initial load required by 5.3.1(b) is to be not less than the total connected emergency statutory load~~.~~ , or if their total consumer load is applied in steps, the following requirements are to be met:

(a) the total load is supplied within 45 seconds from power failure on the main switchboard;
(b) the maximum step load is declared and demonstrated; and
(c) the power distribution system is designed such that the declared maximum step loading is not exceeded.

5.3.3 Compliance of time delays and loading sequence with the requirements of 5.3.2 is to be demonstrated at ship's trials.

~~*5.3.3*~~ *5.3.4* For alternating current installations, the permanent speed variation of the machines intended for parallel operation are to be equal within a tolerance of ±0,5 per cent. Momentary speed variations with load changes in accordance with 5.3.1 are to return to and remain within one per cent of the final steady state speed. This should normally be accomplished within five but in no case more than eight seconds. For quality of power supplies, *see* Pt 6, Ch 2,1.7.

■ *Section 13*
Type testing procedure for crankcase explosion relief valves

13.1 Scope

13.1.1 To specify type tests and identify standard test conditions using methane gas and air mixture to demonstrate that ~~This test procedure identifies standard conditions by which~~ LR requirements are satisfied for crankcase explosion relief valves intended to be fitted to ~~diesel~~ engines and gear cases ~~can be tested to demonstrate that they satisfy LR requirements for type testing to a defined standard~~.

~~*13.1.2* This test procedure is also applicable to explosion relief valves intended for gear cases.~~

~~*13.1.3* Standard repeatable test conditions have been established using a methane gas and air mixture.~~

~~*13.1.4*~~ *13.1.2* The test procedure is only applicable to explosion relief valves fitted with flame arresters. Where internal oil wetting of a flame arrester is a design feature of an explosion relief valve, alternative testing arrangements that demonstrate compliance with these requirements may be proposed by the manufacturer. The alternative testing arrangements are to be submitted to LR for approval.

13.3 Test facilities

13.3.1 ~~The test facilities for~~ Test houses carrying out type testing of crankcase explosion relief valves are to meet the following requirements:

(a) The test ~~facilities~~ houses where testing is carried out are to be accredited to a National or International Standard for the testing of explosion protection devices such as ISO/IEC 17025.
(b) The test facilities are to be acceptable to LR.
(c) The test facilities are to be equipped so that they can ~~control~~ perform and record explosion testing in accordance with this procedure.
(d) The test facilities are to have equipment for controlling and measuring a methane gas in air concentration within a test vessel to an accuracy of ± 0,1%.
(e) The test facilities are to be capable of effective point-located ignition of a methane gas in air mixture.
(f) The pressure measuring equipment is to be capable of measuring the pressure in the test vessel in at least two positions, one at the valve and the other at the test vessel centre. The measuring arrangements are to be capable of measuring and recording the pressure changes throughout an explosion test at a frequency recognising the speed of events during an explosion. The result of each test is to be documented by video recording and ~~if necessary~~ by recording with a heat sensitive camera.
(g) The test vessel for explosion testing is to have documented dimensions. ~~that are to be such that its height or length between dished ends is approximately 2 times its diameter but not more than 2,5 times~~ The dimensions are to be such that the vessel is not pipe-like with the distance between dished ends being not more than 2,5 times the diameter. The internal volume of the test vessel is to ~~be determined from the vessel dimensions that~~ include any standpipe arrangements.
(h) The test vessel ~~for explosion testing~~ is to be provided with a flange, located centrally at one end at 90 degrees to the vessel longitudinal axis for mounting the explosion relief valve. The test vessel is to be arranged in an orientation ~~in an orientation~~ consistent with how the valve ~~it~~ will be installed in service, i.e., in the vertical plane or the horizontal plane. ~~The flange arrangement is to be made approximately one third of the height or length of the test vessel.~~

(j) A circular flat plate ~~having the following dimensions~~ is to be provided for fitting between the pressure vessel flange and valve to be tested with the following dimensions:
  (i) Outside diameter ~~= 2 x *D* where *D* is~~ of 2 times the outer diameter of the valve top cover. ~~The circular plate is to provide simulation of the crankcase surface.~~
  (ii) Internal bore having the same internal diameter as the valve to be tested.

(k) The test vessel ~~for explosion testing~~ is to have connections for measuring the methane in air mixture ~~in~~ at ~~least two positions, i.e.,~~ the top and bottom.

(l) The test vessel ~~for explosion testing~~ is to be provided with a means of fitting an ignition source at a position ~~approximately one third the height or length of the vessel, see~~ as specified in 13.4.3.

(m) The test vessel volume is to be as far as practicable, related to the size and capability of the relief valve to be tested. In general, the volume is to correspond to the requirement in 6.3.1 for the free area of explosion relief valve to be not less than 115 cm^2/m^3 of crankcase gross volume, e.g., the testing of a valve having 1150 cm^2 of free area, would require a test vessel with a volume of 10 m^3. ~~In no case is the volume of the test vessel to vary by more than +15 per cent to –10 per cent or from the 115 cm^2/m^3 volume ratio.~~
The following is to apply:
  (i) Where the free area of relief valves is greater than 115 cm^2/m^3 of the crankcase gross volume, the volume of the test vessel is to be consistent with the design ratio.
  (ii) In no case is the volume of the test vessel to vary by more than ±15 per cent from the design cm^2/m^3 volume ratio.

13.4 Explosion test process

13.4.1 All explosion tests to verify the functionality of crankcase explosion relief valves are to be carried out using an air and methane mixture with a volumetric methane concentration of 9,5 per cent ±0,5 per cent. The pressure in the test vessel is to be not less than atmospheric and is not to exceed ~~0,2 bar~~ the opening pressure of the relief valve.

13.4.3 The ignition of the methane and air mixture is to be made at the centreline of the test vessel at a position approximately one third of the height or length of the test vessel opposite to where the valve is mounted.

13.4.4 The ignition is to be made using a maximum 100 joule explosive charge.

13.5 Valves to be tested

13.5.1 The valves used for type testing (including testing specified in 13.5.3) are to be ~~manufactured and tested in accordance with procedures acceptable to LR and~~ selected from the manufacturer's ~~usual~~ normal production line for such valves by the LR Surveyor witnessing the tests.

13.5.2 For approval of a specific valve size, three valves ~~of that specific size~~ are to be tested in accordance with 13.5.3 and 13.6. For a series of valves, *see* 13.8. ~~The valves are to have been tested at the manufacturer's works to demonstrate that the opening pressure is in accordance with that agreed by the engine builder and valve manufacturer within a tolerance of ±20 per cent and that the valve is air tight at a pressure below the opening pressure for at least 30 seconds.~~

13.5.3 The valves selected for type testing are to have been previously tested at the manufacturer's works to demonstrate that the opening pressure is in accordance with the specification within a tolerance of ± 20 per cent and that the valve is air tight at a pressure below the opening pressure for at least 30 seconds. This test is to verify that the valve is air tight following assembly at the manufacturer's works and that the valve begins to open at the required pressure demonstrating that the correct spring has been fitted.

~~*13.5.3*~~ *13.5.4* The ~~selection~~ type testing of valves ~~for type testing~~ is to recognize the orientation in which they are intended to be installed on the engine or gear case. ~~Where it is intended that valves be installed in the vertical or near vertical or the horizontal or near horizontal position, then three~~ Three valves of each size are to be tested for each intended installation orientation, i.e. in the vertical and/or horizontal positions.

13.6 Method

13.6.1 The following requirements are to be satisfied at explosion testing:

(a) The explosion testing is to be witnessed by a LR Surveyor ~~where type testing approval is required by LR~~.

~~(b) Valves are to be tested in the vertical or horizontal position consistent with the orientation in which they are intended to be installed on an engine or gear case, usually in the vertical position, see 13.5.3.~~

~~(c)~~ (b) Where valves are to be installed on an engine or gear case with shielding arrangements to deflect the emission of explosion combustion products, the valves are to be tested with the shielding arrangements fitted.

~~(d) Type testing is to be carried out for each range of valves for which a manufacturer requires LR approval~~.

~~(e)~~ (c) Successive explosion testing to establish a valve's functionality is to be carried out as quickly as possible during stable weather conditions.

~~(f)~~ (d) The pressure rise and decay during all explosion testing is to be recorded.

~~(g)~~ (e) The external condition of the valves is to be monitored during each test for indication of any flame release by video and heat sensitive camera. ~~The test facility is to produce a report on the explosion test findings.~~

13.6.3 **Stage 1.** Two explosion tests are to be carried out in the test vessel ~~with the flange opening fitted~~ with the circular plate as specified in 13.3.1(j) fitted and the opening in the plate covered by a 0,05 mm thick polythene film. These tests establish a reference pressure level for determination of the ~~effects~~ capability of a relief valve in terms of pressure rise in the test vessel, *see* 13.7.1(f).

13.6.4 **Stage 2**:

(a) Two explosion tests are to be carried out on three different valves of the same size. Each valve is to be mounted in the orientation for which approval is sought i.e., in the vertical or horizontal position with the circular plate described in 13.3.1(j) located between the valve and pressure vessel mounting flange.

(b) The first of the two tests on each valve is to be carried out with a 0,05mm thick polythene bag, having a minimum diameter of three times the diameter of the circular plate and volume not less than 30 per cent of the test vessel, enclosing the valve and circular plate. Before carrying out the explosion test the polythene bag is to be empty of air. The polythene bag is required to provide a readily visible means of assessing whether there is flame transmission through the relief valve following an explosion.During the test, the explosion pressure will open the valve and some unburned methane/air mixture will be collected in the polythene bag. When the flame reaches the flame arrester and if there is flame transmission through the flame arrester, the methane/air mixture in the bag will be ignited and this will be visible.

(c) Provided that the first explosion test successfully demonstrated that there was no indication of combustion outside the flame arrester and there are no signs of damage to the flame arrester or valve, a second explosion test without the polythene bag arrangement is to be carried out as quickly as possible after the first test. During the second explosion test, the valve is to be visually monitored for any indication of combustion outside the flame arrester and video records are to be kept for subsequent analysis. The second test is required to demonstrate that the valve can still function in the event of a secondary crankcase explosion.

(d) After each explosion, the test vessel is to be maintained in the closed condition for at least 10 seconds to enable the tightness of the valve to be ascertained. The tightness of the valve can be verified during the test from the pressure/time records or by a separate test after completing the second explosion test.

13.7 Assessment and records

13.7.1 ~~Assessment of the valves after~~ For the purposes of verifying compliance with the requirements of this Section, the assessment and records of the valves used for explosion testing is to address the following:

(a) The valves to be tested are to have evidence of appraisal/approval by LR, *see also* 13.5.1.

(b) The designation, dimensions and characteristics of the valves to be tested are to be recorded. This is to include the free area of the valve and of the flame arrester and the amount of valve lift at 0,2 bar.

(c) The test vessel volume is to be determined and recorded.

(d) For acceptance of the functioning of the flame arrester there is not to be any indication of flame or combustion outside the valve during an explosion test.

(e) The pressure rise and decay during an explosion is to be recorded, with indication of the pressure variation showing the maximum overpressure and steady underpressure in the test vessel during testing. The pressure variation is to be recorded at two points in the pressure vessel.

(f) The effect of an explosion relief valve in terms of pressure rise following an explosion is ascertained from maximum pressures recorded at the centre of the test vessel during the three stages. The pressure rise within the test vessel due to the installation of a relief valve is the difference between average pressure of the four explosions from Stages 1 and 3 and the average of the first tests on the three valves in Stage 2. The pressure rise is not to exceed the limit specified by the manufacturer.

(g) The valve tightness is to be ascertained by verifying from the records at the time of testing that an under-pressure of at least 0,3 bar is held by the test vessel for at least 10 seconds following an explosion. This test is to verify that the valve has effectively closed and is reasonably gas-tight following dynamic operation during an explosion.

(h) After each explosion test in Stage 2, the external condition of the flame arrester is to be examined for signs of serious damage and/or deformation that may affect the operation of the valve.

(j) After completing the explosion tests, the valves are to be dismantled and the condition of all components ascertained and documented. In particular, any indication of valve sticking or uneven opening that may affect the operation of the valve is to be noted. Photographic records of the valve condition are to be taken and included in the report.

13.8 Design series qualification

13.8.2 The quenching ability of a flame ~~screen~~ arrester depends on the total mass of quenching lamellas/mesh. Provided the materials, thickness of materials, length ~~depth~~ of lamellas/thickness of mesh layer and the quenching gaps are the same, then the same quenching ability can be qualified for different sizes of flame ~~arrestors~~ arresters subject to (a) and (b) being satisfied.

(a) $$\frac{n_1}{n_2} = \sqrt{\frac{S_1}{S_2}}$$

(b) $$\frac{A_1}{A_2} = \frac{S_1}{S_2}$$

where

n_1 = total depth of flame arrester corresponding to the number of lamellas of size 1 quenching device for a valve with a relief area equal to S_1

n_2 = total depth of flame arrester corresponding to the number of ~~lamella~~ lamellas of size 2 quenching device for a valve with a relief area equal to S_2

A_1 = free area of quenching device for a valve with a relief area equal to S_1

A_2 = free area of quenching device for a valve with a relief area equal to S_2

13.8.3 The qualification of explosion relief valves of larger sizes than that which has been previously satisfactorily tested in accordance with 13.6 and 13.7 can be evaluated where valves are of identical type and have identical features of construction subject to the following:

(a) The free area of a larger valve does not exceed three times ±5 per cent that of the valve that has been satisfactorily tested.

(b) One valve of the largest size, subject to (a), requiring qualification is subject to satisfactory testing required by 13.5.3 and 13.6.4 except that a single valve will be accepted in 13.6.4(a) and the volume of the test vessel is not to be less than one third of the volume required by 13.3.1(m).
(c) The assessment and records are to be in accordance with 13.7, noting that 13.7.1(f) will only be applicable to Stage 2 for a single valve.

13.8.4 The qualification of explosion relief valves of smaller sizes than that which has been previously satisfactorily tested in accordance with 13.6 and 13.7 can be evaluated where valves are of identical type and have identical features of construction subject to the following:
(a) The free area of a smaller valve is not less than one third of that of the valve that has been satisfactorily tested.
(b) One valve of the smallest size, subject to (a), requiring qualification is subject to satisfactory testing required by 13.5.3 and 13.6.4 except that a single valve will be accepted in 13.6.4(a) and the volume of the test vessel is not to be more than the volume required by 13.3.1(m).
(c) The assessment and records are to be in accordance with 13.7, noting that 13.7.1(f) will only be applicable to Stage 2 for a single valve.

13.9 The report

13.9.1 The test ~~facility~~ house is to deliver a full report that includes the following information and documents:
(a) Test specification.
(b) Details of test pressure vessel and valves tested.
(c) The orientation in which the valve was tested, (vertical or horizontal position).
(d) Methane in air concentration for each test.
(e) Ignition source.
(f) Pressure curves for each test.
(g) Video recordings of each valve test.
(h) The assessment and records stated in 13.7.

13.10 Approval

13.10.1 The approval ~~Approval~~ of an explosion relief valve is at the ~~prorogative~~ discretion of LR based on the appraisal of plans and particulars and the test facility's report of the results of type testing.

■ *Section14*
Type testing procedure for crankcase oil mist detection/monitoring and alarm arrangements

14.1 Scope

~~*14.1.1* This test procedure identifies standard conditions by which crankcase oil mist detection/monitoring and alarm equipment and systems intended to be fitted to diesel engines can be tested to demonstrate that they satisfy LR requirements for type testing to a defined standard.~~

14.1.1 To specify the tests required to demonstrate that crankcase oil mist detection and alarm equipment intended to be fitted to diesel engines satisfy LR requirements.

14.1.2 This test procedure is also applicable to oil mist detection~~/monitoring~~ and alarm arrangements intended for gear cases.

14.2 Purpose

14.2.1 The purpose of type testing crankcase oil mist detection~~/monitoring~~ and alarm ~~arrangements~~ equipment is seven fold:
(a) To verify the functionality of the system.
(b) To verify the effectiveness of the oil mist detectors.
(c) To verify the accuracy of oil mist detectors.
(d) To verify the alarm set points.
(e) To verify time delays between oil mist leaving the source ~~extraction from crankcase~~ and alarm activation.
(f) To verify ~~the operation of alarms to indicate~~ functional failure ~~in the equipment and associated arrangements~~ detetction.
(g) To verify ~~that there is an indication when optical obscuration has reached a level that will affect the reliability of information and alarms~~ the influence of optical obscuration on detection.

14.3 Test facilities

14.3.1 ~~The test house~~ Test houses carrying out type testing of crankcase ~~oil mist~~ detection~~/monitoring~~ and alarm equipment ~~and arrangements is~~ are to satisfy the following criteria:
(a) ~~The test facilities are to have the full range of facilities for carrying the type and functionality tests required by this procedure~~ A full range of facilities for carrying out the environmental and functionality tests required by this procedure shall be available and be acceptable to LR.
(b) The test house that verifies ~~that~~ the functionality of the equipment ~~ascertains the levels of oil mist concentration~~ is to be equipped so that it can control, measure and record oil mist concentration levels in terms of mg/l to an accuracy of ±10 per cent in accordance with this procedure.
~~(c) The type tests are to be witnessed by a LR Surveyor unless otherwise agreed.~~
~~(d) The oil mist concentrations are to be ascertained by the gravimetric deterministic method or equivalent. The gravimetric deterministic method is a laboratory process where the difference in weight of a millipore (typically 0,8 µm) filter is ascertained by weighing the filter before and after drawing 1dm^3 of oil mist through the filter.~~
~~(e) The results of a gravimetric analysis are considered invalid and are to be rejected if the resultant calibration curve has an increasing gradient with respect to the oil mist detection/monitoring reading. This situation occurs when insufficient time has been allowed for the oil mist to become homogeneous. Single results that are more than 10 per cent below the calibration curve are to be rejected. This situation occurs when the integrity of the filter unit has been compromised and not all of the oil is collected on the filter paper.~~

~~(f) The filters are required to be weighed to a precision of 0,1 mg and the volume of air/oil mist sampled to a precision of 10 ml.~~

14.4 Equipment testing

14.4.2 The range of tests is to include the following for the detectors:

(a) Functional tests described in 14.5.
(b) Electrical power supply failure test.
(c) Power supply variation test.
(d) Dry heat test.
(e) Damp heat test.
(f) Vibration test.
(g) EMC test where susceptible.
~~(g)~~ (h) Insulation resistance test.
~~(h)~~ (j) High voltage test.
~~(i)~~ (k) Static and dynamic inclinations~~, if moving parts are contained~~.

14.5 Functional test ~~process~~

14.5.1 All tests to verify the functionality of crankcase oil mist detection~~/monitoring devices~~ and alarm equipment are to be carried out in accordance with 14.5.2 to 14.5.6 with an oil mist concentration in air, known in terms of mg/l to an accuracy of ±10 per cent.

14.5.2 The concentration of oil mist in the test ~~vessel~~ chamber is to be measured in the top and bottom of the ~~vessel~~ chamber and these concentrations are not to differ by more than 10 per cent. *See* 14.7.2(a).

14.5.3 The oil mist monitoring arrangements are to be capable of detecting oil mist in air concentrations of between 0 and 10 per cent of the lower explosive limit (LEL), which corresponds to an oil mist concentration of approximately 50 mg/l (13 per cent oil-air mixture) or between 0 and a percentage corresponding to a level not less than twice the maximum oil mist concentration alarm set point.

14.5.4 The ~~operation of the~~ alarm set point ~~indicators~~ for oil mist concentration in air ~~are to be verified and are~~ is to provide an alarm at a maximum setting corresponding to not more than 5 per cent of the LEL or approximately 2,5 mg/l.

14.5.5 Where alarm set points can be altered, the means of adjustment and indication of set points are to be verified against the equipment manufacturer's instructions.

14.5.6 Where oil mist is drawn into a detector~~/monitor~~ via piping arrangements, the time delay between the sample leaving the crankcase and operation of the alarm is to be determined for the longest and shortest lengths of pipes recommended by the manufacturer. The pipe arrangements are to be in accordance with the manufacturer's instructions/recommendations.

14.5.7 Detector equipment that is in contact with the crankcase atmosphere and may be exposed to oil splash and spray from engine lubricating oil is to be tested to demonstrate that openings do not occlude or become blocked under continuous oil splash or spray conditions. Testing is to be in accordance with arrangements proposed by the manufacturer and agreed by LR.

14.5.8 Detector equipment may be exposed to water vapour from the crankcase atmosphere which may affect the sensitivity of the equipment, it is to be demonstrated that exposure to such conditions will not affect the functional operation of the detector equipment. Where exposure to water vapour and/or water condensation has been identified as a possible source of equipment malfunctioning, testing is to demonstrate that any mitigating arrangements such as heating are effective. Testing is to be in accordance with arrangements proposed by the manufacturer and agreed by LR. This testing is in addition to that required by 14.4.2(e) and is concerned with the effects of condensation caused by the detection equipment being at a lower temperature than the crankcase atmosphere.

14.6 Detectors~~/monitors~~ and alarm equipment to be tested

14.6.1 The detectors~~/monitors~~ and alarm equipment ~~used in~~ selected for the type testing are to be ~~manufactured and tested in accordance with procedures acceptable to LR and~~ selected from the manufacturer's ~~usual~~ normal production line ~~for such equipment~~ by the LR Surveyor witnessing the tests.

14.6.2 Two ~~sets of~~ detectors~~/monitors requiring approval~~ are to be tested. One ~~set~~ is to be tested in the clean condition and the other in a condition ~~that represents~~ representing the maximum ~~degree~~ level of lens obscuration ~~that is stated as being acceptable~~ specified by the manufacturer.

14.7 Method

14.7.1 The ~~following~~ requirements of 14.7 are to be satisfied at type testing:

~~(a) The testing is to be witnessed by a LR surveyor where type testing approval is required by LR.~~
~~(b) Oil mist detection/monitoring devices are to be tested in the orientation in which they intended to be installed on an engine or gear case.~~
~~(c) Type testing is to be carried out for each range of oil mist detection/monitoring devices that a manufacturer requires LR approval.~~
~~(d) The test house is to produce a test report.~~

14.7.2 Oil mist generation is to satisfy the following:

(a) Oil mist is to be generated with suitable equipment using an SAE 80 monograde mineral oil or equivalent and supplied to a test chamber having a volume of not less than 1 m^3. The oil mist produced is to have a maximum droplet size of 5 µm. The oil droplet size is to be checked using the sedimentation method.

(b) The oil mist concentrations used are to be ascertained by the gravimetric deterministic method or equivalent. For this test, the gravimetric deterministic method is a process where the difference in weight of a 0,8 µm pore size membrane filter is ascertained from weighing the filter before and after drawing 1 litre of oil mist through the filter from the oil mist test chamber. The oil mist chamber is to be fitted with a recirculating fan.

(c) Samples of oil mist are to be taken at regular intervals and the results plotted against the oil mist detector output. The oil mist detector is to be located adjacent to where the oil mist samples are drawn off.

(d) The results of a gravimetric analysis are considered invalid and are to be rejected if the resultant calibration curve has an increasing gradient with respect to the oil mist detection reading. This situation occurs when insufficient time has been allowed for the oil mist to become homogeneous. Single results that are more than 10 per cent below the calibration curve are to be rejected. This situation occurs when the integrity of the filter unit has been compromised and not all of the oil is collected on the filter paper.

(e) The filters require to be weighed to a precision of 0,1 mg and the volume of air/oil mist sampled to 10 ml.

14.7.3 The testing is to be witnessed by an LR Surveyor where type testing approval is required by LR.

14.7.4 Oil mist detection equipment is to be tested in the orientation (vertical, horizontal or inclined) in which it is intended to be installed on an engine or gear case as specified by the equipment manufacturer.

14.7.5 Type testing is to be carried out for each type of oil mist detection and alarm equipment for which a manufacturer seeks LR approval. Where sensitivity levels can be adjusted, testing is to be carried out at the extreme and mid-point level settings.

14.8 Assessment

14.8.1 Assessment of oil mist detection~~/monitoring devices~~ equipment after testing is to address the following:

(a) The ~~devices~~ equipment to be tested ~~are~~ is to have evidence of design appraisal/approval by LR, *See also* 14.6.1.

(b) ~~The details~~ Details of the detection~~/monitoring devices~~ equipment to be tested are to be recorded~~. This is to include~~ such as name of manufacturer, type designation, oil mist concentration assessment capability and alarm settings.

(c) After completing the tests, the detection~~/monitoring devices are~~ equipment is to be examined and the condition of all components ascertained and documented. Photographic records of the monitoring ~~devices~~ equipment condition are to be taken and included in the report.

14.9 Design series qualification

14.9.1 The approval of one type of detection~~/monitoring device~~ equipment may be used to qualify other devices having identical construction details. Proposals are to be submitted for consideration.

14.10 The ~~Report~~ report

14.10.1 The test house is to provide a full report which includes the following information and documents:

(a) Test specification.

(b) Details of ~~devices~~ equipment tested.

(c) Results of tests.

14.11 Acceptance

14.11.1 Acceptance of crankcase oil mist detection~~/monitoring devices is the prerogative~~ equipment is at the discretion of LR based on the appraisal of plans and particulars and the test house report of the results of type testing.

14.11.2 The following information is to be submitted to LR for acceptance of oil mist detection~~/monitoring~~ equipment and alarm arrangements:

(a) Description of oil mist detection~~/monitoring~~ equipment and system including alarms.

(b) Copy of the test house report identified in 14.10.

(c) Schematic layout of engine oil mist detection~~/monitoring~~ arrangements showing location of detectors/sensors and piping arrangements and dimensions.

(d) Maintenance and test manual which is to include the following information:

- Intended use of equipment and its operation.
- Functionality tests to demonstrate that the equipment is operational and that any faults can be identified and corrective actions notified.
- Maintenance routines and spare parts recommendations.
- Limit setting and instructions for safe limit levels.
- Where necessary, details of configurations in which the equipment is and is not to be used.

Part 5, Chapter 4
Gas Turbines

CORRIGENDUM

■ *Section 1*
General requirements

1.4 Gas turbine type approval

1.4.1 New gas turbine types or developments of existing types are to be type approved in accordance with Lloyd's Register's (hereinafter referred to as 'LR') *Type Approval System Procedure – Test Specification ~~GT98~~ GT04*.

Part 5, Chapter 6
Main Propulsion Shafting

Effective date 1 July 2008

■ *Section 3*
Design

3.8 Coupling bolts

3.8.1 ~~The diameter of the bolts~~ Close tolerance fitted bolts transmitting shear are to have a diameter, at the joining faces of the couplings ~~is to be~~ not less than given by the following formula:

$$\text{Diameter of coupling bolts} = \sqrt{\frac{240}{nD}\ \frac{10^6}{\sigma_u}\ \frac{P}{R}} \quad \text{mm}$$

where

n = number of bolts in the coupling
D = pitch circle diameter of bolts, in mm
σ_u = specified minimum tensile strength of bolts, in N/mm^2
P (H) and R are as defined in Ch 1,3.3.

3.8.2 At the joining faces of couplings, other than within the crankshaft and at the thrust shaft/crankshaft coupling, the Rule diameter of the coupling bolts defined in 3.8.1 may be reduced by 5,2 per cent for ships classed exclusively for smooth water service, and 2,6 per cent for ships classed exclusively for service on the Great Lakes.

3.8.3 Where dowels or expansion bolts are fitted to transmit torque in shear they are to comply with the requirements of 3.8.1. The expansion bolts are to be installed, and the bolt holes in the flanges are to be correctly aligned, in accordance with manufacturer's instructions.

3.8.4 The minimum diameter of tap bolts or of bolts in clearance holes at the joining faces of coupling flanges, pretensioned to 70 per cent of the bolt material yield strength value, is not to be less than:

$$d_R = 1{,}348 \sqrt{\left(\frac{120\ 10^6 F P (1 + C)}{R D} + Q\right) \frac{1}{n \sigma_y}}$$

where d_R is taken as the lesser of:

(a) Mean of effective (pitch) and minor diameters of the threads.
(b) Bolt shank diameter away from threads. (Not for waisted bolts which will be specially considered.)

P (H) and R are as defined in Ch 1,3.3.

F = 2,5 where the flange connection is not accessible from within the ship
= 2,0 where the flange connection is accessible from within the ship
C = ratio of vibratory/mean torque values at the rotational speed being considered
D = pitch circle diameter of bolt holes, in mm
Q = external load on bolt in N (+ve tensile load tending to separate flange, –ve)
n = number of tap or clearance bolts
σ_y = bolt material yield stress in N/mm^2.

3.8.5 Consideration will be given to those arrangements where the bolts are pretensioned to loads other than 70 per cent of the material yield strength.

3.8.6 Where clamp bolts are fitted they are to comply with the requirements of 3.8.4 and are to be installed, and the bolt holes in the flanges correctly aligned, in accordance with manufacturer's instructions.

Part 5, Chapter 8
Shaft Vibration and Alignment

Effective date 1 July 2008

■ *Section 1*
General

~~5.6~~ 1.3 Flexible couplings

~~*5.6.1*~~ *1.3.1* Where the shafting system incorporates flexible couplings, the effects of such couplings on the various modes of vibration are to be considered, *see* Sections 2, 3 and 4.

■ *Section 2*
Torsional vibration

2.2 Particulars to be submitted

2.2.3 Enginebuilder's harmonic torque data used in the torsional vibration calculations, *see* 2.3.3.

Existing paragraphs 2.2.3 *to* 2.2.6 *are to be renumbered* 2.2.4 *to* 2.2.7.

■ *Section 4*
Lateral vibration

4.3 Calculations

4.3.2 The calculated natural frequencies of the system are to be compared to both the shaft rotational orders and propeller blade passing frequencies. Where cardan shafts are fitted, the shaft second rotational orders are also to be considered.

Existing paragraph 4.3.2 *is to be renumbered* 4.3.3.

■ *Section 5*
Shaft alignment

5.1 General

~~*5.1.1* The Builder is to carry out shaft alignment calculations for all installations and to prepare alignment procedures detailing the proposed alignment method and the alignment checks to demonstrate compliance with requirements of this section.~~

5.1.1 Shaft alignment calculations are to be carried out for main propulsion shafting rotating at propeller speed, including the crankshaft of direct drive systems or the final reduction gear wheel on geared installations. The Builder is to make available shaft alignment procedures detailing the proposed alignment method and checks for these arrangements.

5.2 Particulars to be submitted for approval – shaft alignment calculations

5.2.1 Shaft alignment calculations are to be submitted to LR for approval for the following shafting systems ~~where the screwshaft has a diameter of 250 mm or greater in way of the aftermost sterntube bearing~~:

(a) All geared installations, where the screwshaft has a diameter of 300 mm or greater in way of the aftmost bearing.

(b) ~~Installations with one shaftline bearing, or less, inboard of the sterntube bearing/seal.~~ All direct drive installations which incorporate 3 or less bearings supporting the intermediate and screwshaft aft of the prime mover.

(c) Where prime movers or shaftline bearings are installed on resilient mountings.

(d) All systems where the screwshaft has a diameter of 800 mm or greater in way of the aftmost bearing.

5.3 ~~Particulars to be submitted for review – shaft alignment procedure~~ Shaft alignment procedures

(*Part only shown*)

5.3.1 A shaft alignment procedure is to be ~~submitted~~ made available for review and for the information of the attending surveyors for all main propulsion installations detailing, as a minimum, ~~the:~~

Part 5, Chapter 10
Steam Raising Plant and Associated Pressure Vessels

Effective date 1 January 2008

■ *Section 15*
Mountings and fittings for cylindrical and vertical boilers, steam generators, pressurized thermal liquid and pressurized hot water heaters

15.2 Safety valves

15.2.9 Safety valves for shell type exhaust gas steaming economizers are to incorporate fail safe features which will ensure operation of the valve even with solid matter deposits on the valve and guide, or features that will prevent the accumulation of solid matter in way of the valve and in the clearance between the valve spindle and guide. Alternatively, if the fitted valves do not incorporate the features described then a bursting disc discharging to a suitable waste steam pipe is to be fitted in addition to the valves. These ~~emergency devices~~ bursting discs are to function at a pressure not exceeding ~~1,5~~ 1,25 times the economizer approved design pressure and are to have sufficient capacity to prevent damage to the economizer when operating at its design heat input level. ~~Full particulars of the proposed arrangements are to be submitted for consideration.~~

15.2.10 To avoid the accumulation of solid matter deposits on the outlet side of safety valves and bursting discs, the discharge pipes and safety valve/bursting disc housings are to be fitted with drainage arrangements from the lowest part, directed with continuous fall to a position clear of the economizer where it will not pose a threat to either personnel or machinery. No valves or cocks are to be fitted in the drainage arrangements.

15.2.11 Full particulars of the proposed arrangements are to be submitted for consideration.

Existing paragraphs 15.2.10 *to* 15.2.13 *are to be renumbered* 15.2.12 *to* 15.2.15.

15.12 Additional requirements for shell type exhaust gas steaming economizers

15.12.1 The design and construction of shell type economizers are to pay particular attention to the welding, heat treatment and inspection arrangements at the tube plate connection to the shell.

15.12.2 Every shell type economizer is to be provided with removable lagging at the circumference of the tube end plates to enable ultrasonic examination of the tube plate to shell connection.

15.12.3 Every economizer is to be provided with arrangements for pre-heating and de-aeration, and addition of water treatment or combination thereof, to control the quality of feed water to within the manufacturer's recommendations.

15.12.4 The manufacturer is to provide operating instructions for each economizer which is to include reference to:

- Feed water treatment and sampling arrangements.
- Operating temperatures – exhaust gas and feed water temperatures.
- Operating pressure.
- Inspection and cleaning procedures.
- Records of maintenance and inspection.
- The need to maintain adequate water flow through the economizer under all operating conditions.
- Periodical operational checks of the safety devices to be carried out by the operating personnel and to be documented accordingly.
- Procedures for using the exhaust gas economizer in the dry condition.
- Procedures for maintenance and overhaul of safety valves.
- Emergency operating procedures.

Part 5, Chapter 12
Piping Design Requirements

Effective date 1 July 2008

■ *Section 8*
Hydraulic tests on pipes and fittings

8.1 Hydraulic tests before installation on board

8.1.3 Where testing of systems or sub-systems following final assembly is specified, in addition to the requirements of 8.1.2 the lowest applicable pressure as defined in this sub-section is to be used for testing.

Existing paragraphs 8.1.3 *to* 8.1.5 *are to be renumbered* 8.1.4 *to* 8.1.6.

~~*8.1.6*~~ *8.1.7* ~~All valve bodies are to be tested by hydraulic pressure to 1,5 times the nominal pressure rating at ambient temperature. However, the test pressure need not be more than 70 bar (71 kgf/cm^2) above the design pressure specified for the design temperature.~~ Valves and fittings non-integral with the piping system, intended for Classes I and II, are to be tested in accordance with recognised standards, but to not less than 1,5 times the design pressure. Where design features are such that modifications to the test requirements are necessary, alternative proposals for hydraulic tests are to be submitted for special consideration.

8.1.8 For requirements relating to valves and cocks intended to be fitted on the ship's side below the load water line, *see* Pt 5, Ch 13,2.5.10.

~~*8.1.7*~~ *8.1.9* In no case is the membrane stress to exceed 90 per cent of the yield stress at the testing temperature.

Part 5, Chapter 13
Ship Piping Systems

■ *Section 1*
General requirements

1.3 Plans and particulars

(*Part only shown*)

1.3.1 The following plans (in diagrammatic form) and particulars are to be submitted for approval. Additional plans should not be submitted unless the arrangements are of a novel or special character affecting classification:

(e) Bilge drainage arrangements for all compartments which are to include details of location, number and capacity of pumping units on bilge service. In the case of passenger ships, the ~~criterion~~ bilge pump numeral, as defined in the *International Convention for the Safety of Life at Sea, 1974*, and applicable amendments are to be stated, together with the number of flooded compartments which the ship is required to withstand under damage conditions.

■ *Section 6*
Pumps on bilge service and their connections

6.1 Number of pumps

6.1.5 For passenger ships, at least three power bilge pumps are to be provided, one of which may be operated from the main engines. Where the ~~criterion~~ bilge pump numeral as derived from Regulation ~~6.3~~ 35-1 of Chapter II-1 of the *International Convention for the Safety of Life at Sea, 1974*, and applicable amendments, is 30 or more, one additional independent power pump is to be provided.

■ *Section 8*
Additional requirements for bilge drainage and cross-flooding arrangements for passenger ships

8.1 Location of bilge pumps and bilge main

8.1.2 In passenger ships of 91,5 m or more in length, or having a ~~criterion~~ bilge pump numeral of 30 or more (*see* 6.1.5), the arrangements are to be such that at least one power pump will be available for use in all ordinary circumstances in which the ship may be flooded at sea. This requirement will be satisfied if:

- one of the pumps is an emergency pump of a submersible type having a source of power situated above the bulkhead deck, or
- the pumps and their sources of power are so disposed throughout the length of the ship that, under any conditions of flooding which the ship is required by statutory regulation to withstand, at least one pump in an undamaged compartment will be available.

Part 5, Chapter 14
Machinery Piping Systems

Effective date 1 July 2008

■ *Section 2*
Oil fuel – General requirements

2.1 Flash point

2.1.6 Tanks containing oil fuel are to be separated from crew, passenger and baggage compartments by either:
- a gastight steel division additional to the division which retains the oil, or
- a division of all-welded steel construction capable of withstanding a head of water at least 1.5 metres greater than the maximum service head.

Part 5, Chapter 15
Piping Systems for Oil Tankers

Effective date 1 July 2008

■ *Section 1*
General requirements

1.7 Cargo pump room ventilation

1.7.5 Protection screens of not more than 13 mm square mesh are to be fitted in outside openings of ventilation ducts, and ventilation intakes are to be so arranged as to minimize the possibility of re-cycling hazardous vapours from any ventilation discharge opening. Vent exits are to be arranged to discharge ~~upwards~~ to a safe place on the open deck and comply with the requirements of 1.7.6.

■ *Section 2*
Piping systems for bilge, ballast, oil fuel, etc.

2.1 Pumping arrangements at ends of ship outside dangerous zones and spaces

2.1.4 Where non-permanent connections are required in piping systems between non-dangerous and dangerous spaces, two means of isolation are to be provided. One of these means is to provide positive separation by means of a removable spool piece or flexible hose, and blank flanges are to be fitted. The other is to be a non-return valve, or similar, in accordance with an acceptable National or International Standard that is appropriate for the design conditions of the piping system. The non-return valve and removable piece are to be located outside the non-dangerous space. A notice is also to be provided located in a prominent position adjacent to the means of isolation, clearly indicating that the spool piece or flexible hose is to be removed, and blanking flanges are to be fitted, when the piping is not in use.

Part 5, Chapter 19
Steering Gear

Effective date 1 July 2008

■ *Section 9*
'Guidelines' for the acceptance of non-duplicated rudder actuators for tankers, chemical tankers and gas carriers of 10 000 tons gross and upwards but of less than 100 000 tons deadweight

9.5 Testing

9.5.1 Tests, including hydrostatic tests, of all pressure parts at 1,5 times the design pressure should be carried out subject to any limitations imposed by valves and other components. Where additional testing of systems or sub-systems following final assembly is required, the test pressure may be subject to any limitations imposed by valves and other components.

9.5.2 When installed on board the ship, the rudder actuator should be subjected to a hydrostatic test at the pressure defined in 9.5.1 and a running test.

Part 5, Chapter 23
Podded Propulsion Units

Effective date 1 July 2008

■ *Section 1*
Scope

1.1 General

1.1.7 The design of a podded propulsor system is to take into account a range of operating conditions which are to include the following:

- All ahead seagoing conditions up to and including the maximum rated output of the podded propulsor while maintaining a steady course under foreseeable sea and wind conditions.
- The ability of the ship to change direction rapidly at the declared steering angles with the ship running at maximum ahead service speed.
- Executing a steady turning manoeuvre with a tactical diameter not greater than 5*L* and advance not greater than 4,5*L* whilst maintaining a power corresponding to the test speed, where L is the length measured between the aft and forward perpendiculars. Test speed is defined as a speed of at least 90 per cent of the ship's speed corresponding to 85 per cent of the maximum rated power of the podded propulsor.
- Changing heading, manoeuvring in and out of harbour both ahead and astern, at slow speeds, stationary and starting from rest in foreseeable current and wind conditions.
- Berthing manoeuvres in the case of azimuthing podded propulsion units.
- Rapid acceleration and deceleration manoeuvres where the ship's operating profile demands this capability.
- Holding stationary positions over-ground under different conditions.
- Stopping manoeuvre as required by Ch 1,5.2.
- Manoeuvring in ice where ice class is required.

■ *Section 2*
General requirements

2.2 Plans and information to be submitted

(*Part only shown*)

2.2.1 In addition to the plans required by Chapters 5, 6, 7, 8, 14 and 19, and Pt 6, Ch 1 and Ch 2, the following plans and information are required to be submitted for appraisal:

(j) Supporting data ~~calculations~~ and direct calculation reports. This is to include, where applicable, an assessment of anticipated global accelerations acting on the ship's machinery and equipment which may potentially affect the reliable operation of the propulsion system for all foreseeable seagoing and operating conditions. Typically, this may include response to slamming, extreme ship motions and pod interaction. *See also* 1.1.5.

(l) ~~Nozzle ring structure and nozzle support details if applicable to the application.~~ Nozzle structure, its support arrangements, together with related calculations for all permitted operating conditions where the propeller operates in a nozzle (duct), *see* Pt 3, Ch 13,3.

~~(u) Recommended installation, inspection, maintenance and component replacement procedures (*see also* 5.1.2). This is to include any in-water/underwater engineering procedures where recommended by the pod manufacturer. *See also* 6.5.7 and Section 10.~~

~~(v)~~ (u) Identification of any potentially hazardous atmospheric conditions together with details of how the hazard will be countered, this should include a statement of the maximum anticipated air temperature within the pod during full power steady state operation, *see* 2.3.

~~(w)~~ (v) ~~Access~~ Where provided, access and closing arrangements for pod unit inspection and maintenance.

~~(x)~~ (w) Heat balance calculations for pods having an electric propulsion motor but no active cooling system, *see* 6.7.4.

~~(y)~~ (x) Details of proposed testing and trials required by Section 9.

~~(z)~~ (y) Details of emergency steering and pod securing arrangements. *See* 6.3.11.

2.2.3 Recommended installation, inspection, maintenance and component replacement procedures (*see also* 5.1.2). This is to include any in-water/underwater engineering procedures where recommended by the pod manufacturer. *See also* 6.5.7 and Section 10.

2.4 Global loads

~~*2.4.2* Where the maximum loads and moments described in 2.4.1 cannot be readily identified from calculation methods or are based on model testing, the estimated loads and moments are to be stated at pod unit steering angular intervals of 5 degrees over the range from ahead to astern for the relevant combinations of shaft rotational and ship speed.~~ Where the maximum forces and moments defined in 2.4.1 cannot be accurately calculated, then, an estimate of these loadings is to be stated together with an assessment of the associated error tolerances for the sequences of permitted design manoeuvres (*see* 1.1.7). Typically this will include emergency astern manoeuvres, zig zag manoeuvres and pod interaction. Such estimates are to be defined on a load versus pod angle basis. In the case of pod to pod and/or pod to ship hydrodynamic interaction effects these, must be defined for the most severely affected propulsor.

2.4.5 The podded propulsor is to be capable of withstanding a blade root failure due to fatigue occurring at the maximum rated output of the podded propulsor without initiating a failure in other parts of the propulsor system.

■ *Section 5*
Structure design and construction requirements

5.1 Pod structure

5.1.2 Means are to be provided to enable the shaft, bearings and seal arrangements to be ~~fully~~ examined in accordance with LR's requirements and the manufacturer's recommendations ~~at docking Survey to the Surveyor's satisfaction~~.

5.1.6 ~~Vertical~~ For fabricated structures, vertical and horizontal plate diaphragms are to be arranged within the strut and, where necessary, secondary stiffening members are to be arranged.

5.1.7 Pod unit structure scantling requirements are shown in Table 23.5.1. Where the scantling requirements in Table 23.5.1 ~~are not~~ cannot be satisfied, direct calculations carried out in accordance with 5.3 may be considered.

5.1.9 The structural response under the most onerous combination of loads is not to exceed the normal operational requirements of the propulsion or steering system components.

5.1.10 For cast pod structures, the elongation of the material on a gauge length of $5{,}65\sqrt{S_o}$ is to be not less than 12 per cent where S_o is the actual cross sectional area of the test piece.

5.1.11 In castings, sudden changes of section or possible constriction to the flow of metal during casting are to be avoided. All fillets are to have adequate radii, which should, in general, be not less than 75 mm.

5.1.12 Castings are to comply with the requirements of Chapter 4 or Chapter 7 of the Rules for Materials (Part 2).

Table 23.5.1 Podded propulsion unit – fabricated structure ~~structural~~ requirements

Table 23.5.2 Direct calculation maximum permissible stresses for steel fabricated structures

5.3 Direct calculations

5.3.6 For cast structures, the localised von Mises stress should not exceed 0,6 times the nominal 0,2 per cent proof or yield stress of the material for the most onerous design condition.

■ *Section 6*
Machinery design and construction requirements

6.1 General

6.1.2 Means are to be provided whereby normal operation of the podded propulsion system can be sustained or readily restored if one of the supporting auxiliaries becomes inoperative. *See also* 2.1.1. Consideration shall be given to the malfunctioning of:

- sources of lubricating oil pressure,
- sources of cooling,
- hydraulic, pneumatic or electrical means fro control of the podded propulsor.

6.3 Propulsion shafting

6.3.11 ~~On multi-podded ships,~~ In multi-podded propulsor systems or ships having at least one pod in association with other propulsion devices and where the individual pod installed power is greater than 5MW, means are to be provided to hold the propeller ~~on~~ for an inoperable unit stationary whilst the other pod(s) propel the vessel at a manoeuvring speed of not less than 7 knots. Operating instructions displayed at the holding mechanism's operating position are to include a direction to inform the bridge of any limitation in ship's speed required as a result of the holding mechanism being activated.

6.5 Bearing lubrication system

6.5.1 The bearing lubrication system is to be arranged to provide a sufficient quantity of ~~lubricating oil~~ lubricant of a quality, viscosity and temperature acceptable to the bearing manufacturer under all ship operating conditions.

6.5.3 ~~The~~ For systems employing forced lubrication, the sampling points required by ~~Ch 14,8.9~~ Ch 14,8.9.6 are to be located such that the sample taken is representative of the oil present at the bearing.

6.5.4 For lubricating oil systems employing gravity feed, the arrangements are to be such as to permit oil sampling and oil changes in accordance with the manufacturer's instructions for the safe and reliable operation of the propulsion system.

Existing paragraphs 6.5.4 *to* 6.5.7 *are to be renumbered* 6.5.5 *to* 6.5.8*.*

~~*6.5.5*~~ *6.5.6* Where bearings are grease lubricated, means are to be provided for collecting waste grease to enable analysis for particulates and water. The arrangements for collecting waste grease are to be in accordance with the pod manufacturer's recommendations. Alternative arrangements which demonstrate that bearings are satisfactorily lubricated will be considered.

CORRIGENDUM

6.7 Ventilation and cooling systems

6.7.4 For pods having an electric propulsion motor but no active cooling system, heat balance calculations as required by ~~2.2.1(x)~~ 2.2.1(w) are to demonstrate that the pod unit and associated systems are able to function satisfactorily over all operating conditions, *see* Ch 1,3.5.

Effective date 1 July 2008

6.8 Pod drainage requirements

6.8.2 ~~Two~~ Where the design of a pod space has a requirement to be maintained in a dry condition, two independent means of drainage are to be provided so that liquid leakage may be removed from the pod unit at all design angles of heel and trim, *see* Ch 1,3.6.

■ *Section 8*
Control engineering arrangements

8.1 General

8.1.8 For electronic control systems and electrical actuating systems, the quality plan for sourcing, design, installation and testing of components is to address the following issues:

(a) Standard(s) applied.
(b) Details of the quality control system applied during manufacture and testing.
(c) Details of type approval, type testing or approved type status assigned to the equipment.
(d) Details of installation and testing recommendations for the equipment.
(e) Details of any local and/or remote diagnostic arrangements where assessment and alteration of control parameters can be made which can affect the operation of the podded propulsor unit.
(f) Details of arrangements for software upgrades.

8.1.9 The system integration plan is required to identify the process for verification of the functional outputs from the electronic control systems with particular reference to system integrity, consistency, security against unauthorised changes to software and maintaining the outputs within acceptable tolerances of stated performance for safe and reliable operation of the podded propulsor unit.

8.1.10 For the permitted range of operating conditions, the control system is to be capable of protecting the podded propulsor from experiencing mechanical loads that may initiate damage while permitting the desired manoeuvres to take place.

8.2 Monitoring and alarms

8.2.4 Pod unit ~~bilge~~ dry space pumping arrangements are to function automatically in the event of a high liquid level being detected in the pod unit.

8.2.5 Spaces intended to be dry are to be provided with arrangements to indicate water ingress in accordance with 8.2.6 and Table 23.8.1.

Table 23.8.1 Specific alarms for pod control systems

Item	Alarm	Note
Podded drive azimuth angle	—	Indicator, *see* 8.1.4
Propulsion motors	Overload, power failure	To be indicated on the navigating bridge
Hydraulic oil system pressure	Low	To be indicated on the navigating bridge
Bearing temperature	High	For grease lubricated bearings
Motor temperature	High	*See* Pt 6, Ch 15,1.3
Lubricating oil supply pressure	Low	If separate forced lubrication for shaft bearings; to be indicated on the navigating bridge
Lubricating oil temperature	High	
Lubricating oil tank level for motor bearings	Low	
Water in lubricating oil for motor bearings	High	Required for single podded propulsion units only
Motor cooling air inlet temperature	High	
Motor cooling air outlet temperature	High	
Motor cooling air flow	Low	
Shaft bearing vibration monitoring	High	*See* 6.3.10. Monitoring is to allow bearing condition to be gauged using trend analysis
~~Bilge~~ Dry space water pump operation	Abnormal	Alarm set to indicate a frequency or duration exceeding that which would normally be expected
~~Bilge~~ Dry space water level	High	

~~8.2.5~~ *8.2.6* The number and location of ~~bilge~~ dry space level detectors are to be such that accumulation of liquids will be detected at all design angles of heel and trim.

~~8.2.6~~ *8.2.7* Condition monitoring arrangements are not to interface with the operation of safety systems which may cause slow-down or shut-down of the propulsion system. *See also* Pt 6, Ch 1,2.6.9.

CORRIGENDUM

■ *Section 10*

Installation, maintenance and replacement procedures

10.1 General

10.1.1 All podded propulsion units are to be supplied with a copy of the manufacturer's installation and maintenance manual that is pertinent to the actual equipment. ~~*See* 2.2.1(u)~~.

Part 6, Chapter 1

Control Engineering Systems

Effective date 1 July 2008

■ *Section 3*

Control and supervision of unattended machinery

3.9 Auxiliary engines and auxiliary steam turbines

3.9.1 Alarms and safeguards are indicated in Table 1.3.8, *see also* 3.1.5 and 3.1.6.

(*Part only shown*)

Table 1.3.8 Auxiliary engines and auxiliary steam turbines: Alarms and safeguards

Item	Alarm	Note
OIL ENGINES		
Coolant outlet temperature (for engines >220 kW)	1st stage high	—
	2nd stage high	Automatic shutdown of engine*, *see* 3.1.4

NOTES
1. ~~There are no classification requirements for the items marked * in the case of~~ For emergency diesel engines, including engines ~~being~~ used for the emergency source of electrical power required by SOLAS, *see* Pt 5, Ch 2,16.
2. The arrangements are to comply with the requirements of the National Authority concerned.

■ *Section 7*

Trials

7.1 General

7.1.3 Acceptance tests and trials for programmable electronic systems are to include verification of software lifecycle activities appropriate to the stage in the system's lifecycle at the time of system examination.

Part 6, Chapter 2
Electrical Engineering

Effective date 1 July 2008

■ *Section 1*
General requirements

1.1 General

1.3.5 For ships having the class notation **OPS**, in addition to the equipment listed in 1.3.2, the following Connection Equipment covered by Pt 7, Ch 15, where applicable, is to be surveyed by the Surveyors during manufacture and testing:

- flexible cables, with assembled plug and socket-outlets, if any;
- busbar trunking;
- filters;
- converters; and
- slip ring assemblies.

Existing paragraph 1.3.5 *is to be renumbered* 1.3.6.

■ *Section 3*
Emergency source of electrical power

3.1 General

3.1.2 For ships assigned a Service Restriction Notation in accordance with Pt 1, Ch 2, a lesser period than the 36 hour period and 18 hour period specified in ~~3.2.5~~ 3.2.7 and ~~3.3.5~~ 3.3.7 respectively may be considered, but not less than 12 hours.

3.2 Emergency source of electrical power in passenger ships

~~*3.2.3* The location of the emergency source of electrical power and associated transforming equipment, if any, the transitional source of emergency power, the emergency switchboard and the emergency lighting switchboard in relation to the main source of electrical power, associated transforming equipment, if any, and the main switchboard is to be such as to ensure that a fire or other casualty in spaces containing the main source of electrical power, associated transforming equipment, if any, and the main switchboard or in any machinery space of Category A will not interfere with the supply, control and distribution of emergency electrical power. The space containing the emergency source of electrical power, associated transforming equipment, if any, the transitional source of emergency electrical power and the emergency switchboard is not to be contiguous to the boundaries of machinery spaces of Category A and those spaces containing the main source of electrical power, associated transforming equipment, if any, or the main switchboard. Where this is not practicable, details of the proposed arrangements are to be submitted.~~

3.2.3 The location of:

- the emergency source of electrical power and associated transforming equipment, if any;
- the transitional source of emergency power;
- the emergency switchboard; and
- the emergency lighting switchboard;

in relation to:

- the main source of electrical power, associated transforming equipment, if any; and
- the main switchboard;

is to be such as to ensure that a fire or other casualty in spaces containing:

- the main source of electrical power, associated transforming equipment, if any, and the main switchboard; or
- in any machinery space of Category A;

will not interfere with the supply, control and distribution of emergency electrical power.

3.2.4 The space containing:

- the emergency source of electrical power, associated transforming equipment, if any;
- the transitional source of emergency electrical power; and
- the emergency switchboard;

is not to be contiguous to the boundaries of machinery spaces of Category A or those spaces containing:

- the main source of electrical power, associated transforming equipment, if any; or
- the main switchboard.

3.2.5 Where compliance with 3.2.3 or 3.2.4 is not practicable, details of the proposed arrangements are to be submitted.

Existing paragraphs 3.2.4 *to* 3.2.13 *are to be renumbered* 3.2.6 *to* 3.2.15.

(*Part only shown*)

~~*3.2.5*~~ *3.2.7* The electrical power available is to be sufficient to supply all those services that are essential for safety in an emergency, due regard being paid to such services as may have to be operated simultaneously. The emergency source of electrical power is to be capable, having regard to starting currents and the transitory nature of certain loads, of supplying simultaneously at least the following services for the periods specified hereinafter, if they depend upon an electrical source for their operation:

(h) Where connected, the supplementary lighting required by 3.2.16.

(*Part only shown*)

~~*3.2.6*~~ *3.2.8* The emergency source of electrical power may be either a generator or an accumulator battery, which are to comply with the following:

(a) Where the emergency source of electrical power is a generator it is to be:

(ii) started automatically upon failure of the electrical supply from the main source of electrical power and is to be automatically connected to the emergency switchboard; those services referred to in ~~3.2.5~~ 3.2.7 are then to be transferred automatically to the emergency generating set. The automatic starting system and the characteristics of the prime mover are to be such as to permit the emergency generator to carry its full rated load as quickly as is safe and practicable, subject to a maximum of 45 seconds; and

(iii) provided with a transitional source of emergency electrical power according to ~~3.2.7~~ 3.2.9.

(b) Where the emergency source of electrical power is an accumulator battery, it is to be capable of:

(iii) immediately supplying at least those services specified in ~~3.2.7~~ 3.2.9.

(*Part only shown*)

~~*3.2.7*~~ *3.2.9* The transitional source of emergency electrical power required by ~~3.2.6~~ 3.2.8 is to consist of an accumulator battery suitably located for use in an emergency which is to operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12 per cent above or below its nominal voltage and be of sufficient capacity and so arranged as to supply automatically in the event of failure of either the main or emergency source of electrical power at least the following services, if they depend upon an electrical source for their operation:

(a) For half an hour:

(i) the lighting required by ~~3.2.5~~ 3.2.7(a) and (b);

(ii) all services required by ~~3.2.5~~ 3.2.7(c)(i), (iii) and (iv) unless such services have an independent supply for the period specified from an accumulator battery suitably located for use in an emergency.

(iii) Where connected, the supplementary lighting required by 3.2.16.

(b) Power to operate the watertight doors at least three times, i.e. closed-open-closed against an adverse list of 15°, but not necessarily all of them simultaneously, together with their control, indication and alarm circuits as required by ~~3.2.5~~ 3.2.7(f)(i).

~~*3.2.12*~~ *3.2.14* In order to ensure the ready availability of the emergency source of electrical power to supply ~~emergency~~ circuits required to provide emergency services, arrangements are to be made, where necessary, to automatically disconnect non-emergency circuits from the emergency switchboard ~~to ensure that electrical power is available to the emergency circuits. The arrangements are to automatically disconnect sufficient non-emergency loads to ensure continued safe operation of the emergency source of electrical power~~ in the event of overloading to ensure that electrical power is available to the emergency circuits.

3.2.16 In passenger ships, supplementary lighting is to be provided in all cabins to clearly indicate the exit so that occupants will be able to find their way to the door. Such lighting, which may be connected to an emergency source of power or have a self-contained source of electrical power in each cabin, is to automatically illuminate when power to the normal cabin lighting is lost and remain on for a minimum of half an hour.

(*Part only shown*)

~~*3.2.14*~~ *3.2.17* In addition to the emergency lighting required by ~~3.2.5(a)~~ 3.2.7(a) passenger ships with roll on–roll off cargo spaces or special category spaces are to be provided with the following:

3.3 Emergency source of electrical power in cargo ships

~~*3.3.3* The location of the emergency source of electrical power and associated transforming equipment, if any, the transitional source of emergency power, the emergency switchboard and the emergency lighting switchboard in relation to the main source of electrical power, associated transforming equipment, if any, and the main switchboard are to be such as to ensure that a fire or other casualty in the space containing the main source of electrical power, associated transforming equipment, if any, and the main switchboard, or in any machinery space of Category A will not interfere with the supply, control and distribution of emergency electrical power. The space containing the emergency source of electrical power, associated transforming equipment, if any, the transitional source of emergency electrical power and the emergency switchboard is not to be contiguous to the boundaries of machinery spaces of Category A or those spaces containing the main source of electrical power, associated transforming equipment, if any, and the main switchboard. Where this is not practicable, details of the proposed arrangements are to be submitted.~~

3.3.3 The location of:

- the emergency source of electrical power and associated transforming equipment, if any;
- the transitional source of emergency power;
- the emergency switchboard; and
- the emergency lighting switchboard;

in relation to:

- the main source of electrical power, associated transforming equipment, if any; and
- the main switchboard;

is to be such as to ensure that a fire or other casualty in spaces containing:

- the main source of electrical power, associated transforming equipment, if any, and the main switchboard; or
- in any machinery space of Category A;

will not interfere with the supply, control and distribution of emergency electrical power.

3.3.4 The space containing:
- the emergency source of electrical power, associated transforming equipment, if any;
- the transitional source of emergency electrical power; and
- the emergency switchboard;

is not to be contiguous to the boundaries of machinery spaces of Category A or those spaces containing:
- the main source of electrical power, associated transforming equipment, if any; or
- the main switchboard.

3.3.5 Where compliance with 3.3.3 or 3.3.4 is not practicable, details of the proposed arrangements are to be submitted.

Existing paragraphs 3.3.4 *to* 3.3.13 *are to be renumbered* 3.3.6 *to* 3.3.15.

(*Part only shown*)

~~*3.3.6*~~ *3.3.8* The emergency source of electrical power may be either a generator or an accumulator battery, which is to comply with the following:

(a) Where the emergency source of electrical power is a generator it is to be:
  (ii) started automatically upon failure of the main source of electrical power supply unless a transitional source of emergency electrical power in accordance with ~~3.3.7~~ 3.3.9 is provided; where the emergency generator is automatically started, it is to be automatically connected to the emergency switchboard; those services referred to in ~~3.3.7~~ 3.3.9 are to be connected automatically to the emergency generator; and
  (iii) provided with a transitional source of emergency electrical power as specified in ~~3.3.7~~ 3.3.9 unless an emergency generator is provided capable both of supplying the services mentioned in that paragraph and of being automatically started and supplying the required load as quickly as is safe and practicable subject to a maximum of 45 seconds.

(b) Where the emergency source of electrical power is an accumulator battery it is to be capable of:
  (iii) immediately supplying at least those services specified in ~~3.3.7~~ 3.3.9.

~~*3.3.7*~~ *3.3.9* The transitional source of emergency electrical power where required by ~~3.3.6~~ 3.3.8 is to consist of an accumulator battery suitably located for use in an emergency which is to operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12 per cent above or below its nominal voltage and be of sufficient capacity and is to be so arranged as to supply automatically in the event of failure of either the main or the emergency source of electrical power for half an hour at least the following services if they depend upon an electrical source for their operation:

(a) the lighting required by ~~3.3.5~~ 3.3.7(a), (b) and (c). For this transitional phase, the required emergency electric lighting, in respect of the machinery space and accommodation and service spaces may be provided by permanently fixed, individual, automatically charged, relay operated accumulator lamps; and

(b) all services required by ~~3.3.5~~ 3.3.7(d)(i), (iii) and (iv) unless such services have an independent supply for the period specified from an accumulator battery suitably located for use in an emergency.

~~*3.3.12*~~ *3.3.14* In order to ensure the ready availability of the emergency source of electrical power to supply ~~emergency~~ circuits required to provide emergency services, arrangements are to be made, where necessary, to automatically disconnect non-emergency circuits from the emergency switchboard ~~to ensure that electrical power is available to the emergency circuits. The arrangements are to automatically disconnect sufficient non-emergency loads to ensure continued safe operation of the emergency source of electrical power~~ in the event of overloading to ensure that electrical power is available to the emergency circuits.

■ *Section 4*
External source of electrical power

4.1 Temporary external supply

4.1.5 Alternative arrangements may be submitted for consideration. *See also* Pt 7, Ch 15 for class notation **OPS**.

■ *Section 5*
Supply and distribution

5.3 Isolation and switching

5.3.2 Isolation and switching is to be by means of a circuit-breaker or switch arranged to open and close simultaneously all insulated poles. Where a switch is used as the means of isolation and switching, it is to be capable of:

(a) switching off the circuit on load;
(b) withstanding, without damage, the overcurrents which may arise during overloads and short-circuit.

In addition, these requirements do not preclude the provision of single pole control switches in final sub-circuits, for example light switches. For circuit-breakers, *see* 6.5 and 7.3.

■ *Section 6*
System design – Protection

6.1 General

6.1.3 The protection of circuits is to be such that a fault in a circuit does not cause the interruption of supplies used to provide emergency or essential services other than those dependent on the circuit where the fault occurred. For circuits used to provide essential services which need not necessarily be in continuous operation to maintain propulsion and steering but which are necessary for maintaining the vessel's safety, arrangements that ensure that a fault in a circuit does not cause the sustained interruption of supply to healthy circuits may be accepted. Such arrangements are to ensure the supply to healthy circuits is automatically re-established in sufficient time after a fault in a circuit.

Existing paragraghs 6.1.3 *to* 6.1.9 *are to be renumbered* 6.1.4 *to* 6.1.10.

~~*6.1.6*~~ *6.1.7* ~~Except where arrangements comply with 11.3.5, protection~~ Protection for battery circuits is to be provided at a position external and adjacent to the battery compartments. Where arrangements comply with 11.3.5, the protection may be installed at a suitable location in the battery compartment.

6.5 Circuit-breakers

6.5.1 Circuit-breakers for alternating current systems are to satisfy the following conditions:

(a) the r.m.s. symmetrical breaking current for which the device is rated is to be not less than the r.m.s. value of the a.c. component of the prospective fault current, at the ~~instant of contact separation~~ first half cycle;

(b) the peak asymmetrical making current for which the device is rated is not to be less than the peak value of the prospective fault current at the first half cycle, allowing for maximum asymmetry;

(c) the power factor at which the device short-circuit ratings are assigned is to be no greater than that of the prospective fault current; alternatively for high voltage, the rated percentage d.c. component of the short-circuit breaking current of the device is to be not less than that of the prospective fault current.

6.5.4 To satisfy 6.5.3, the rated service short-circuit breaking capacity of low voltage circuit-breakers:

- directly connected to main or emergency switchboard; and/or
- installed in the feeder lines for circuits used to provide essential or emergency services;

is to be not less than the prospective fault current referred to in 6.5.1(a). Low voltage circuit-breakers for other circuits may be selected on the basis of their rated ultimate short-circuit breaking capacity.

6.5.5 The rated short-time withstand current of low voltage circuit-breakers which are required to have an intentional short-time delay under short-circuit conditions to ensure discriminative action with respect to other protective devices, is to be not less than the r.m.s. value of the a.c. component of the prospective fault current, at the first half cycle.

6.9 Load management

6.9.1 Arrangements are to be made to disconnect automatically, after an appropriate time delay, circuits of the following categories, when the generator(s) is/are overloaded; sufficient to ensure the connected generating set(s) is/are not overloaded:

(a) non-essential circuits;

(b) circuits feeding services for habitability, *see* 1.5.2;

(c) in cargo ships, circuits for cargo refrigeration.

NOTE:

For emergency generators *see* ~~3.2.12~~ 3.2.14 and ~~3.3.12~~ 3.3.14 as applicable.

■ *Section 7*
Switchgear and control gear assemblies

7.1 General requirements

7.1.1 Switchgear and control gear assemblies and their components are to comply with one of the following standards amended where necessary for ambient temperature and other environmental conditions:

(a) IEC 60439: *Low voltage switchgear and control gear assemblies*;

(b) ~~IEC 60298: *AC Metal enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 72.5 kV*~~ *IEC 62271-200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*;

(c) IEC 60466: *AC insulated-enclosed switchgear for rated voltages above 1 kV and up to and including 38 kV*;

(d) IEC 60255: *Electrical relays*;

(e) acceptable and relevant National Standard.

In addition, the requirements of 7.2 to 7.19 are to be complied with.

7.3 Circuit-breakers

7.3.2 Circuit-breakers are to be capable of isolation.

Existing paragraphs 7.3.2 *and* 7.3.3 *are to be renumbered* 7.3.3 *and* 7.3.4.

7.12 Instrument scales

7.12.4 Where the indications provided by the instrumentation required by 7.11 are displayed digitally, nominal voltage, over voltage, over current and reverse power indications are to be indicated by an appropriate means. The information provided is to be clearly visible and immediately available.

7.16 Position of switchboards

7.16.5 For switchgear and control gear assemblies, for rated voltages above 1 kV, arrangements are to be made to protect personnel in the event of gases or vapours escaping under pressure as the result of arcing due to an internal fault. Where personnel may be in the vicinity of the equipment when it is energised, this may be achieved by an assembly that has been tested in accordance with Annex A of IEC 62271-200 and qualified for classification **IAC** (internal arc classification).

7.18 Testing

7.18.5 For switchgear and control gear assemblies, for rated voltages above 1 kV, type tests are to be carried out, in accordance ~~with an appropriate Standard~~ Annex A of IEC 62271-200 and **IAC** (internal arc classification) assigned, to verify that the assembly will withstand the effects of an internal arc occurring within the enclosure at a prospective fault level equal to, or in excess of, that of the installation.

■ *Section 8*
Rotating machines

8.4 Generator control

8.4.5 Generators and their voltage regulation systems are to be capable of maintaining, without damage, under steady state short-circuit conditions a current of at least three times the full load rated current for a duration of at least two seconds or where precise data is available for the duration of any ~~longer~~ time delay which may be provided by a tripping device for discrimination purposes.

■ *Section 10*
Electric cables and busbar trunking systems (busways)

10.6 Conductor size

10.6.3 The cable current ratings given in Tables 2.10.3 and 2.10.4 are based on the maximum rated conductor temperatures given in Table 2.10.2. When cable sizes are selected on the basis of precise evaluation of current rating based upon experimental and calculated data, details are to be submitted for consideration. Alternative short-circuit temperature limits, other than those given in Table 2.10.4, may be ~~calculated~~ applied using the ~~method~~ data provided in: ~~IEC 60724: *Guide to the short-circuit temperature limits of electric cables*~~

- IEC 60724: *Short-circuit temperature limits of electric cables with rated voltages of 1kV (Um=1,2kV) and 3kV (Um=3,6kV);* or ~~an~~
- IEC 60986: *Short-circuit temperature limits of electric cables with rated voltages from 6kV (Um=7,2kV) and up to 30kV (Um=36kV)*.

Alternative short-circuit temperature limits provided in an acceptable and relevant National Standard may also be considered.

10.8 Installation of electric cables

10.8.2 Bends in fixed electric cable runs are to be in accordance with the cable manufacturer's recommendations. The minimum internal radius of bend for the installation of fixed electric cables is to be chosen according to the construction and size of the cable and is not to be less than the values given in Table 2.10.6.

■ *Section 11*
Batteries

11.3 Location

11.3.11 A permanent notice is to be prominently displayed adjacent to battery installations advising personnel that replacement batteries are to be of an equivalent performance type. For valve-regulated sealed batteries, the notice is to advise of the requirement for replacement batteries to be suitable with respect to products of electrolysis and evaporation being allowed to escape from cells to the atmosphere, *see also* 1.4.3.

11.5 Ventilation

11.5.4 Mechanical exhaust ventilation complying with 11.5.9 is to be provided for battery installations connected to a charging device with a total maximum power output of more than 2 kW. Also, to minimise the possibility of oxygen enrichment, compartments and spaces containing batteries with boost charging facilities are to be provided with mechanical exhaust ventilation irrespective of the charging device power output.

11.5.5 The ventilation system for battery compartments and boxes, other than boxes located on open deck or in spaces to which 11.3.2 ~~and~~ ,11.3.3 and 11.3.5 refer, is to be separate from other ventilation systems. The exhaust ducting is to be led to a location in the open air, where any gases can be safely diluted, away from possible sources of ignition and openings into spaces where gases may accumulate.

Table 2.10.6 Minimum internal radii of bends in cables for fixed wiring

Cable construction		Overall diameter of cable	Minimum internal radius of bend (times overall diameter of cable)
Insulation	Outer covering		
Thermoplastic and elastomeric 600/1000 V and below	Metal sheathed Armoured and braided	Any	6*D*
	Other finishes	≤ 25 mm > 25 mm	4*D* 6*D*
Mineral	Hard metal sheathed	Any	6*D*
Thermoplastic and elastomeric above 600/1000 V – single core	Any	Any	~~20*D*~~ 12*D*
– multicore	Any	Any	~~15*D*~~ 9*D*

■ *Section 13*
Electrical equipment for use in explosive gas atmospheres or in the presence of combustible dusts

13.1 General

13.1.1 The installation of electrical equipment in spaces and locations in which flammable mixtures are liable to collect, e.g. areas containing flammable gas or vapour and/or combustible dust, is to be minimized as far as is consistent with operational necessity and the provision of lighting, monitoring, alarm or control facilities enhancing the overall safety of the ship.

■ *Section 14*
Navigation and manoeuvring systems

14.5 Navigation lights

14.5.1 Navigation lights are to be connected separately to a distribution board reserved for this purpose only and accessible to the officer of the watch. This distribution board is to be connected directly or through transformers to the emergency source of electrical power in compliance with, for passenger ships, ~~3.2.5~~ 3.2.7(b) and ~~3.2.7~~ 3.2.9(a)(i) or, for cargo ships, ~~3.3.5~~ 3.3.7(c) and ~~3.3.7~~ 3.3.9(a).

14.6 Navigational aids

14.6.1 Navigational aids as required by SOLAS are to be fed from the emergency source of electrical power, *see also* ~~3.2.5~~ 3.2.7(c)(ii) and ~~3.3.5~~ 3.3.7(d)(ii).

■ *Section 16*
Fire safety systems

16.1 Fire detection and alarm systems

16.1.6 In passenger ships, the fixed fire detection and fire alarm system are to be capable of remotely and individually identifying each detector and manually operated call point. On other ships, indicating units are to denote, as a minimum, the section in which a detector or manually operated call point has operated. At least one unit is to be so located that it is easily accessible to responsible members of the crew. One indicating unit is to be located on the navigating bridge if the control panel is located in the central control station.

16.1.7 Clear information is to be displayed on or adjacent to each indicating unit about the spaces covered and the location of the section and, for passenger ships, each detector and manually operated call point.

16.1.9 In passenger ships, ~~where the fire detection system does not include means of remotely identifying each detector individually a section of detectors is neither to serve spaces on both sides of the ship nor on more than one deck except when permitted by 16.1.14~~ detectors fitted in cabins, when activated, are also to be capable of emitting, or cause to be emitted, an audible alarm within the space where they are located.

■ *Section 18*
Ship safety systems

18.1 Watertight doors

18.1.1 The electrical power required for power-operated sliding watertight doors is to be separate from any other power circuit and supplied from the emergency switchboard either directly or by a dedicated distribution board situated above the bulkhead deck. The associated control, indication and alarm circuits are to be supplied from the emergency switchboard either directly or by a dedicated distribution board situated above the bulkhead deck and for passenger ships be capable of being automatically supplied by the transitional source of emergency electrical power required by ~~3.2.6~~ 3.2.8 in the event of failure of either the main or emergency source of electrical power.

Part 7, Chapter 4
Dynamic Position Systems

Effective date 1 January 2008

■ *Section 1*
General

1.3 Information and plans required to be submitted

1.3.4 Plans of the following, together with particulars of ratings in accordance with the relevant Parts of the Rules, are to be submitted for:
(a) Prime movers, gearing, shafting, propellers and ~~thrust units~~ thrusters.
(b) Machinery piping systems.
(c) Electrical installations.
(d) Pressure vessels for use with dynamic positioning system.

1.3.5 Plans of control, alarm and safety systems, including the following, are to be submitted:
(a) Functional block diagrams of the control system(s).
(b) Functional block diagrams of the position reference systems and the environmental sensors.
(c) Details of the electrical supply to the control system(s), the position reference system(s) and the environmental sensors.
(d) Details of the monitoring functions of the controllers, sensors and reference ~~system~~ systems, together with a description of the monitoring functions.
(e) List of equipment with identification of the manufacturer, type and model.
(f) Details of the control stations, e.g. control panels and consoles, including the location of the control stations.
(g) Test schedules (for both works testing and sea trials) that are to include the methods of testing and the test facilities provided.

1.3.6 For assignment of a **DP(AA)** or **DP(AAA)** notation, a Failure Mode and ~~Effect~~ Effects Analysis (FMEA) is to be submitted, demonstrating that adequate segregation and redundancy of the machinery, the electrical installation and the control systems have been achieved in order to maintain position in the event of equipment failure (*see* Section 4); or fire or flooding~~,~~ (*see* Section 5). The FMEA is to take a formal and structured approach and is to be performed in accordance with an acceptable and relevant national or international standard, e.g. IEC 60812.

■ *Section 2*
Class notation DP(CM)

2.2 ~~Thrust units~~ Thrusters

2.3 Electrical systems

2.3.3 Where ~~thruster units~~ thrusters are electrically driven, the relevant requirements, including surveys, of Pt 6, Ch 2,15 are to be complied with.

2.3.4 Essential services are those defined in Pt 6, Ch 2,1.5, as applicable, together with thruster auxiliaries, computers, generator and thruster control equipment, reference systems, environmental sensors and electrically driven ~~thruster units~~ thrusters.

2.3.9 On loss of power due to the failure of the operating generator(s), there is to be provision for the automatic starting and connection to the switchboard of a standby set and the automatic sequential restarting of essential services. Consideration may be given to cases where arrangements for automatic re-starting of thrusters would not be practicable. Details are to be submitted in such cases to show that manual means for the immediate re-starting of thrusters would be available at the control station from where the dynamic positioning system would be operated.

2.3.10 Any loads that require an uninterrupted electrical power supply are to be provided with uninterruptible power systems (UPS) having a capacity for a minimum of 30 minutes' operation following loss of the main supply. A UPS is to be provided for each control computer system.

~~*2.3.12* Essential services are to be served by individual feeders. Services that are duplicated are to be supplied from opposite sides of the main switchboard busbar circuit-breaker and their cables are to be separated throughout their length as widely as practical and without the use of common feeders, transformers, convertors, protective devices or control panels and circuits.~~

2.3.12 Essential services are to be served by individual circuits. Essential services that are duplicated are:
(a) to be supplied from independent sections of their switchboard or section board;
(b) to have their circuits separated throughout their length as widely as is practicable; and
(c) not to depend upon common feeders, transformers, converters, protective devices, control circuits or control gear assemblies to operate.

2.4 Control stations

2.4.3 Indication of the following is to be provided at each station from which it is possible to control the dynamic positioning system:
(a) The heading and location of the ship relative to the desired reference point or course.
(b) Vectorial thrust output, individual and total.
(c) Operational status of position reference systems and environmental sensors.
(d) Environmental conditions, e.g. wind speed and direction.
(e) Availability status of standby ~~thruster units~~ thrusters.

2.4.7 Alarms, in accordance with the requirements of Pt 6, Ch 1,2.3, are to be provided for the following fault conditions as applicable:

(a) When the ship deviates from the area of operation.
(b) When the heading exceeds the allowable deviation.
(c) Position reference system fault (for each reference system).
(d) Heading reference sensor fault.
(e) Vertical reference sensor fault.
(f) Wind sensor fault.
(g) Taut wire excursion limit.
(h) Automatic changeover to a standby position reference system or environmental sensor.

A permanent record of the occurrences of alarms and warnings, and of status changes is to be provided.

■ *Section 3* Class notation DP(AM)

3.1 Requirements

3.1.1 For assignment of **DP(AM)** notation, the applicable requirements of Section 2, together with 3.1.2 to ~~3.1.7~~ 3.1.6, are to be complied with.

~~*3.1.7* In the event of failure of any single thruster, the ship is to be capable of maintaining its area of operation and desired heading in the environmental conditions in which the DP system is intended to operate.~~

■ *Section 4* Class notation DP(AA)

4.1 Requirements

4.1.1 For assignment of **DP(AA)** notation, the applicable requirements of Sections 2 and 3, together with 4.1.2 to ~~4.1.9~~ 4.1.10 are to be complied with.

4.1.2 Power, control and thruster systems and other systems necessary for, or which could affect, the correct functioning of the DP system are to be provided and configured such that a fault in any active component or system will not result in a loss of position. This is to be verified by means of a FMEA (*see* 1.3.6). Such components may include, but are not restricted to, the following:

- Prime movers (e.g. auxiliary engines).
- Generators and their excitation equipment.
- Gearing.
- Pumps.
- Fans.
- Switchgear and control gear, including their assemblies.
- Thrusters.
- Valves (where power actuated).

Systems which are not part of the DP system but which, in the event of a fault, could affect the correct functioning of the DP system (for example, fire suppression systems, engine ventilation systems, shutdown systems, etc.) are to be included in the FMEA.

4.1.4 The electrical generation and distribution arrangements are to be isolatable such that ~~no single fault will result in the loss of more than 50 per cent of the generating capacity or~~ at least the minimum number of any duplicated, or otherwise replicated, items required to provide essential services would remain operational in the event of a single fault. Evidence to verify compliance with this requirement is to be submitted for consideration when required; for example, where it is intended to operate with the independent sections required by 2.3.12 connected together; or where division would be via a single circuit breaker. ~~However, when electrically driven thrusters are employed, a reduction in position keeping capability may be accepted, but this is not to result in a loss of position in the environmental conditions in which the DP system is intended to operate.~~

~~*4.1.5* For electrically driven thruster systems, provision is to be made for the automatic starting, synchronizing and load sharing of a non-running generator before the load reaches the alarm level required by 2.3.8.~~

4.1.5 For electrically driven thruster systems:

(a) a reduction in position keeping capability may be accepted, but this is not to result in a loss of position in the environmental conditions in which the DP system is intended to operate; and
(b) provision is to be made for the automatic starting, synchronizing and load sharing of a non-running generator before the load reaches the alarm level required by 2.3.8.

4.1.10 The DP system is to incorporate a computer based consequence analysis to determine whether the position of the vessel would remain within the limits set by the operator in the event of a worst case fault. An audible and visual alarm is to be initiated where the consequence analysis determines that the limits would be exceeded. Where applicable to the timescale for safely terminating operations, the consequence analysis is to allow for manual input of predicted environmental conditions.

■ *Section 7* Testing

7.1 General

7.1.4 Two copies of the dynamic positioning system sea trial test schedules, as required by 1.3.5(g), each signed by the Surveyor and Builder, are to be provided on completion of the survey. One copy is to be placed and retained on board the ship and the other submitted to LR ~~Lloyd's Register (hereinafter referred to as 'LR')~~.

7.1.5 Records and data regarding the performance capability of the dynamic positioning system are to be maintained on board the ship and are to be made available at the time of the Annual Survey, *see* Pt 1, Ch 3,~~2.2.15~~ 2.2.17.

Part 7, Chapter 5
Ships Equipped for Oil Recovery Operations

Effective date 1 July 2008

■ *Section 1* General

1.1 Application

1.1.1 The requirements of this Chapter apply to ships equipped ~~for the recovery of oil floating on the sea and are additional to other applicable Parts of the Rules~~ to handle, store and transport oil recovered from a spill in emergency situations.

1.1.3 For ships of 500 gross tons and over, also fishing vessels of 45 m length and over, it is the responsibility of the Government of the Flag State to give effect to the fire safety measures, *see* Pt 6, Ch 4,1.1. Where the Government of the Flag State has no National Requirements for oil recovery ships, LR ~~Lloyd's Register (hereinafter referred to as 'LR')~~ will apply the fire safety measures required by Section 6 for classification purposes.

1.2 Classification and class notations

1.2.1 A ship ~~primarily intended for oil recovery operations and~~ complying with the requirements of this Chapter will be eligible ~~for the class notation **Oil Recovery Ship** which will be recorded in the *Register Book*~~. for the notation **Oil Recovery**.

~~*1.2.2* A ship not primarily intended for oil recovery operations, which has structural arrangements in accordance with 3.1.7, and which complies with the relevant requirements of this Chapter, will be eligible for the class notation **Occasional Oil Recovery Duties** which will be recorded in the *Register Book*.~~

1.2.2 A ship dedicated solely to oil recovery duties will be given the class notation **Oil Recovery Ship**. The scantlings will be specially considered on the basis of the requirements of Pt 4, Ch 9.

■ *Section 2* Oil recovery

2.1 General

2.1.1 The ship is to be capable of performing the following functions at a safe distance from the source of oil spill:

(a) ~~Separation~~ Removal of the oil ~~film~~ from the surface of the sea.

(b) Handling, storage and transportation of the recovered oil.

2.2 Equipment and ~~principal~~ deck arrangement

2.2.1 The arrangements for collection, handling and transfer of recovered oil are to be such that the probability of oil spill on deck and overflow is minimized and the operation is to be performed as far away from the accommodation spaces as practicable. ~~These arrangements are to include hand rails and gratings or other non-slip surfaces to ensure suitable working conditions.~~

2.2.2 In way of working areas, hand rails and gratings or other non-slip surfaces are to be provided.

~~*2.2.2*~~ *2.2.3* Means are to be provided to keep deck spills away from the accommodation and service areas. This may be accomplished by provision of a permanent continuous coaming not less than 150 mm high.

~~*2.2.3*~~ *2.2.4* At least two portable instruments are to be available on board for gas detection.

~~*2.2.4*~~ *2.2.5* For engines used in oil recovery operations, *see* 4.4.

~~*2.2.5*~~ *2.2.6* Masts and derricks, etc., are to comply with the appropriate sections of Chapters 2 and 3 of LR's *Code for Lifting Appliances in a Marine Environment*.

■ *Section 3* Ship structure

3.1 Structural arrangement

3.1.3 In tanks intended for recovered oil, internal obstructions are to be avoided as far as practicable to prevent the entrapment of foreign objects usually present in recovered oil. Adequate drainage openings are to be provided to ensure free flow of residues to assist in cleaning and gas freeing on completion of recovery operations.

3.1.7 ~~On ships to which 1.2.2 applies,~~ In the case of a ship not primarily intended for oil recovery operations, where cofferdams ~~may be~~ are impractical to arrange~~. In these cases~~, tanks arranged adjacent to machinery spaces may be accepted for storage of recovered oil. Acceptance will be conditional upon the tank boundary bulkheads being readily accessible for inspection. The bulkheads are to be carried continuously through joining structure to the top of the tank, where full penetration welding is to be carried out. Such tanks will require to be pressure tested at every Periodical Survey, *see* Table 1.8.2 in Pt 3, Ch 1, as applicable to oil tankers. Special consideration will be given to arrangements incorporating double bottom tanks in these locations.

3.1.8 All openings to tanks for recovered oil are to be located on the open deck. This includes sounding pipes, vent pipes, and hatches for the deployment of portable pumps and hoses. Suitable access hatches, not less than 600 mm x 600 mm, are to be ~~similarly~~ arranged to facilitate tank cleaning and gas freeing. Dual access hatches, as widely separated as practicable, are to be provided for tanks of a cellular ~~nature~~ internal structure.

~~*3.1.9* Removable manhole covers are to be avoided where practicable, except for access from open deck or void spaces to ballast or fresh water tanks.~~

~~*3.1.10*~~ *3.1.9* Where there is a risk of significant sloshing induced loads, additional strength calculations may be required, *see* Pt 3, Ch 3,5.4.

~~*3.1.11*~~ *3.1.10* Where recovered oil temperatures are to be increased significantly above 65°C during transit voyages, attention is drawn to Pt 4, Ch 9,12 regarding thermal stress considerations.

3.2 Scantlings

3.2.1 ~~The scantlings will receive individual consideration on the basis of Pt 4, Ch 9 and Ch 10, as applicable.~~ The scantlings and arrangements are, in general, to be as required by Pt 4, Ch 1. If the ship is to perform the duties of a supply ship the requirements of Pt 4, Ch 4 are also to be complied with, as applicable.

■ *Section 4* Machinery arrangements

4.2 Pump room for recovered oil

4.2.4 Protection screens of not more than 13 mm square mesh are to be fitted outside openings of ventilation ducts, and ventilation intakes are to be so arranged as to minimize the possibility of recycling hazardous vapours from any ventilation discharge opening. Vent exhausts are to be arranged to discharge ~~upwards~~ to a safe place on the open deck and comply with the requirements of 4.2.5.

NOTE

If the pump room is designed to recover chemicals listed in Chapter 17 of the *International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk, (IBC Code)* the vent exhausts are to be arranged to discharge upwards.

4.5 Miscellaneous

4.5.3 The heating medium supply and return lines are not to penetrate the recovered oil tank plating, other than at the top of the tank~~, and the main supply lines are to run above the weather deck~~. to reduce the possibility of the recovered oil entering the heating system in the event of a failure of the heating pipework within the tank.

Part 7, Chapter 9
Navigational Arrangements for Periodic One Man Watch

Effective date 1 July 2008

■ *Section 1* General requirements

1.2 Information and plans required to be submitted

(*Part only shown*)

1.2.1 The following information and plans are to be submitted in triplicate:

- For programmable electronic systems, the plans required by Pt 6, Ch 1,1.2.5.

■ *Section 3* Workstations

3.1 Navigation workstation

3.1.9 Heading monitoring is to be provided to monitor the actual heading information by independent heading sources. An off-course warning is to be given if the actual heading of the ship deviates from the set track course beyond a pre-set value. The pre-set off-course warning limit is to be large enough to prevent unnecessary alarms.

■ *Section 5* Integrated Bridge Navigation System – IBS notation

5.5 Alarm management

5.5.6 Group alarms may be arranged on the bridge to indicate machinery faults, but alarms associated with faults requiring speed or power reduction or the automatic shut-down of propulsion machinery are to be identified by separate group alarms or by individual alarm parameters.

~~*5.5.6*~~ *5.5.7* The following alarms are not to be grouped:

- Emergency alarms.
- ~~Alarms~~ Seperate group alarms associated with faults requiring speed or power reduction or the automatic shutdown of propulsion machinery.
- Steering gear alarms.

Existing paragraphs 5.5.7 *and* 5.5.8 *are to be renumbered* 5.5.8 *and* 5.5.9.

■ *Section 6* Trials

6.1 General

6.1.2 For **IBS** Notation, testing at the manufacturer's works and trials on board are to be carried out that cover the individual components and their interaction and the bridge functions and their integration to form the Integrated Bridge System.

Existing paragraph 6.1.2 *is to be renumbered* 6.1.3.

6.1.4 Acceptance tests and trials for Programmable Electronic Systems are to include verification of software lifecycle activities appropriate to the stage in the system's lifecycle at the time of system examination.

Part 7, Chapter 11
Arrangements and Equipment for Environmental Protection

Effective date 1 July 2008

■ *Section 2* Environmental Protection (EP) class notation

2.8 Sewage treatment

2.8.8 A suitable piping system from the sewage treatment system or holding tank is to be provided to allow discharge from the system/tank to shore reception facilities. The systems discharge pipe is to terminate with a standard discharge connection complying with the requirements of MARPOL Annex IV, Regulation 10.

Part 7, Chapter 13
Arrangements and Equipment for the Saftey of Bulk Carriers ~~Safety~~ and Single Hold Cargo Ships other than Bulk Carriers

Effective date 1 July 2008

■ *Section 1*
Water ingress detection arrangements

1.1 General requirements

1.1.1 Equipment for detecting the ingress of water in bulk carriers is to be fitted in accordance with the requirements of SOLAS 1974 as amended, Chapter XII, Regulation 12.

1.1.2 Equipment for detecting the ingress of water in single hold cargo ships is to be fitted in accordance with the requirements of SOLAS 1974 as amended, Chapter II-1, Regulation 23-3.

Existing paragraph 1.1.2 *is to be renumbered* 1.2.1.

1.1.3 The audible and visual alarms specified in ~~1.1.2~~ 1.2 and 1.3 are to be located on the navigation bridge.

1.2 Water ingress detection arrangements in bulk carriers

~~*1.1.2*~~ *1.2.1* Bulk carriers are to be fitted with water level detectors:

(a) In each cargo hold, giving audible and visual alarms, one when the water level above the inner bottom in any hold reaches a height of 0,5 m and another at a height not less than 15 per cent of the depth of the cargo hold but not more than 2 m. The water level detectors are to be fitted in the aft end of the cargo holds. For cargo holds which are used for water ballast, an alarm overriding device may be installed. The visual alarms are to clearly discriminate between the two different water levels detected in each hold;

(b) in any ballast tank forward of the collision bulkhead required by Pt 3, Ch 3,4, giving an audible and visual alarm when the liquid in the tank reaches a level not exceeding 10 per cent of the tank capacity. An alarm overriding device may be installed to be activated when the tank is in use; and

(c) in any dry or void space other than a chain cable locker, any part of which extends forward of the foremost cargo hold, giving an audible and visual alarm at a water level of 0,1 m above the deck. Such alarms need not be provided in enclosed spaces the volume of which does not exceed 0,1 per cent of the ship's maximum displacement volume.

1.3 Water ingress detection arrangements in single hold cargo ships

1.3.1 Ships having a length (*L*) of less than 80 m and a single cargo hold below the freeboard deck or cargo holds below the freeboard deck which are not separated by at least one bulkhead made watertight up to that deck, are to be fitted in such space or spaces with water level detectors.

1.3.2 The water level detectors required by 1.3.1 are to:

(a) give an audible and visual alarm when the water level above the inner bottom in the cargo hold reaches a height of not less than 0,3 m, and another when such level reaches not more than 15 per cent of the mean depth of the cargo hold; and

(b) be fitted at the aft end of the hold, or above its lowest part where the inner bottom is not parallel to the designed waterline. Where webs or partial watertight bulkheads are fitted above the inner bottom, the installation of additional detectors is to be considered.

1.3.3 The water level detectors required by 1.3.1 need not be fitted in ships complying with 1.2, or in ships having watertight side compartments each side of the cargo hold length which extend vertically at least from inner bottom to freeboard deck.

Part 7, Chapter 15
On-shore Power Supplies

Effective date 1 July 2008

Section 1
General

1.1

1.1.1 These optional requirements apply to the safety, reliability and availability of shipboard machinery, electrical and control engineering arrangements installed to permit continued operation of services by connection to an external electrical power supply in port. These requirements are additional to those applicable in other Parts of the Rules. Regular operation of ship's services from an external electrical power supply is often referred to as On-shore Power Supply, Cold Ironing, High Voltage Shore Connection or Alternative Marine Power.

1.1.2 These requirements are intended for application to the shipboard elements of designs where the connection(s) with external power supply arrangements are achieved by either extending ship cables from the ship to the external power supply connection points or by bringing external cables on board to connect to shipboard connection points. However, external equipment and machinery (including shore based transformers, circuit breakers, gantries, cables, connectors and control engineering arrangements) are not covered by classification or these requirements.

1.1.3 Compliance with these requirements is intended to assess the suitability of shipboard arrangements for the documented intended application and only addresses compatibility with external power supply arrangements that are suitable for connection to the installed ship arrangements.

1.1.4 Assessment of the overall compatibility and suitability of an external electrical power supply (including combined electrical and control engineering assessments, compliance with applicable regulations, operating practices and risk assessment, etc., as applicable) is necessary before connection and is the responsibility of the Owner. Elements of the overall assessment of compatibility will be required to be completed in advance to prepare for a ship visit to a port where it is intended to connect to an external power supply due to the need to involve competent and responsible parties.

1.2 Authorities and administrations

1.2.1 Additional requirements and/or restrictions may be imposed by the National Authority with which the ship is registered and/or by the appropriate Administration or Authorities within whose jurisdiction the ship is intended to operate and/or by the Owners or Authorities responsible for an external electrical power supply. Where such additional requirements are relevant, compliance is the responsibility of the Owner. If specifically requested, Lloyd's Register (hereinafter referred to as 'LR') may be able to provide a suitable statement of compliance.

1.2.2 Where additional requirements imposed by an Authority or Administration would result in a departure from the requirements of this Chapter, details demonstrating that safety, availability and reliability will not be adversely affected are to be submitted to LR for consideration.

1.3 Class notations

1.3.1 **OPS** machinery class notation may be assigned where machinery, electrical and control engineering arrangements installed onboard to permit continued operation of services by connection to an external electrical power supply are assessed and found to comply with the requirements of this Chapter.

1.4 Plans and information

1.4.1 Three copies of the plans and particulars in 1.4.2 to 1.4.9 are to be submitted for consideration.

1.4.2 Operating Manuals that describe the intended methods of connection together with operating and monitoring instructions. Assessments of the external supplies that are to be connected to the ship together with the mooring and environmental conditions are to be included. Details of equipment and arrangements necessary to ensure safety when connecting, disconnecting, testing and operating are to be incorporated.

1.4.3 A Design Statement which details the Defined Operations. This statement is to include a description of the operating capability, functionality, limits and restrictions; in terms of:

- Connection Equipment, *see* 1.6.2;
- Connection Equipment routes;
- mooring arrangements;
- environmental conditions including tidal and weather and, where applicable, electromagnetic conditions required to ensure compatibility or prevent damage caused by heating or sparking;
- Connection Equipment suitability for hazardous areas, *see* 2.1.4 and Pt 6, Ch 2,1.2.6
- arrangements for an external connection cable to be brought on board, where provided;
- Separation details, *see* 3.2.7;
- the rating of the arrangements;

- ratings and requirements for external power supplies, *see* 3.1.10; and
- the services to be supplied.

1.4.4 Arrangement plans of equipment, control stations, locations, routes to and from connections, openings and accesses and flexible or movable arrangements.

1.4.5 Operational and construction details of Connection Equipment, including any flexible or adjusting arrangements, including plugs and socket-outlets, *see* 3.3.7.

1.4.6 Plans for control and electrical engineering arrangements required by Pt 6, Ch 1 and 2, as applicable.

1.4.7 Details of type tests for Connection cables, plugs and socket-outlets required by 3.3.5.

1.4.8 Details of supplementary arrangements required to protect equipment from exposure to moisture, condensation or temperatures outside their rating.

1.4.9 Schedule of testing at manufacturers' works, initial surveys and trials. The test schedules are to address the defined operations and are to include normal operations and failure conditions.

1.5 Additions and alterations

1.5.1 When an alteration or addition to the approved arrangements is proposed, including changes to the defined service profile, details are to be submitted for consideration.

1.6 Definitions

1.6.1 'Defined Operations' include the application, connection, electrical load transfer, in-service operation, failure response, disconnection and stowage of the connection to an external power supply.

1.6.2 'Connection Equipment' is the ship equipment used to connect permanently installed ship equipment with external electrical power supply connection points in accordance with the Design Statement. This includes, as applicable, flexible cables, plugs and socket-outlets, slip rings or other power conductors or control connections, and support and management measures for these connections. For the purposes of this Chapter, 'Connection Equipment' does not include external equipment, *see* 1.1.

■ *Section 2*
Essential features

2.1 General requirements

2.1.1 Connection equipment is to be designed to be compatible with ship mooring arrangements and the limits of acceptable forces, moments and deflections on correctly applied Connection Equipment resulting from the movement of the moored ship under normal operational circumstances is to be defined in the Design Statement.

2.1.2 Electrical and control engineering arrangements for operation with external electrical power supplies are to be in accordance with the requirements of Pt 6, Ch 1 and 2, as applicable.

2.1.3 Connection to an external electrical power supply is not to adversely affect the availability of main, auxiliary or emergency machinery, including ship sources of electrical power to allow ship power to be restored. Details of arrangements provided to maintain availability (for example, pre-heating and lubrication and availability of starting, fuel, lubrication, air and auxiliary systems) are to be included in the Design Statement, *see also* 4.5 and 5.1.9.

2.1.4 The permanent or temporary installation of electrical equipment in areas containing flammable gas or vapour and/or combustible dust, is to be minimized as far as is consistent with operational necessity and the provision of facilities enhancing the overall safety of the ship and connection to an external power supply. Where it is necessary to install electrical equipment in these areas, the arrangements are to be in accordance with the requirements of Pt 6, Ch 2,13. The suitability of electrical Connection Equipment for operation in areas containing flammable gas and/or vapour and/or combustible dust while in port is to be defined in the Design Statement and should, additionally, address the implications for Connection Equipment extended ashore, where applicable, and the suitability for operation in berths requiring extended, hazardous areas.

2.1.5 As far as practicable, Connection Equipment is to be located outside of areas where it could be damaged by in-port activities under normal operational circumstances.

2.1.6 Consideration may be given to arrangements that are considered by LR to provide an equivalent level of safety or that comply with the provisions of a relevant standard acceptable to LR.

■ *Section 3*
Electrical connection

3.1 General

3.1.1 A connection cubicle is to be provided at a convenient location for the reception or extension of connection cable(s) for connection to the external electrical power supply connection points. The connection cubicle is to contain terminals for the connection cable(s) that can be isolated.

3.1.2 Power connections with external electrical power supply arrangements may be made with either suitable connections or by using socket-outlets and plugs in accordance with 3.3.

3.1.3 Suitable cables, permanently fixed, are to be provided from the connection cubicle to the Connection Circuit-Breaker switchboard, with on-board overcurrent protection situated at or as close as is practicable to the connection cubicle. Connection Equipment to this overcurrent protection is to be installed in a manner such as to minimise the risk of short-circuit.

3.1.4 Where shipboard connection cables are extended to the external electrical power supply connection points, the connection cubicle is to be situated as close as practicable on board to the point where they are extended from the ship.

3.1.5 Means are to be provided to permit the quality of insulation between Connection Equipment conductors, and between the conductors and earth to be measured to verify suitability prior to the connection of an external power supply. The means of verifying satisfactory insulation quality of Connection Equipment in hazardous areas is to be addressed in the Operating Manuals, *see* 1.4.2.

3.1.6 An earth connection is to be provided for connecting the hull to an earth appropriate for the external electrical power supply which is being connected.

3.1.7 For high voltage connections, means are to be provided to verify the continuity of the earth connection referred to in 3.1.6.

3.1.8 Means are to be provided for checking the phase sequence of the incoming supply.

3.1.9 An indicator is to be provided at the Connection Circuit-Breaker switchboard, and at the connection cubicle if in a different location, in order to show when connections are energized.

3.1.10 Requirements for an external electrical power supply to be connected are to be defined in the Design Statement and a notice is to be provided at the connection cubicle indicating the following:

- reference to the Operating Manuals;
- connections, including control, alarm and safety systems and data communication links;
- emergency Shut-Down requirements, *see* 5.3;
- nominal voltage(s) or voltage range;
- nominal frequency or frequency range;
- number of phases and system of supply;
- rated current or apparent power;
- quality of power supply;
- reference to protection system design, including protection characteristics for the Connection Circuit-Breaker;
- maximum permitted prospective fault level;
- minimum supply apparent power or current capacity;
- earth fault limiting requirements for earthed high voltage connections;
- isolation and earthing; and
- supply requirements for lightning and surge protection, galvanic isolation of supply circuit from other ships, etc.

The Notice is to align with the Design Statement and Operating Manuals. *See* 1.1.4 for the conducting of the assessment of overall compatibility.

3.2 Connection Equipment

3.2.1 Connection Equipment support and management arrangements, including those for control engineering arrangements, are to be arranged not to apply damaging forces or tension to correctly applied equipment. Support arrangements are to ensure that the weight of connected cable is not borne by cable end terminations or connections, including those in plugs or socket-outlets.

3.2.2 Connection Equipment arrangements are to be such as not to coil or twist correctly applied equipment in a manner that would result in heating or physical tension beyond its rating during Defined Operations.

3.2.3 Where Connection Equipment passes through support or management arrangements or structural openings or is placed against structures, it is to be suitably protected against damage having regard to the Defined Operations.

3.2.4 Connection Equipment routes are not to reduce the effectiveness of openings required for the safety of the ship, for instance bulkhead or deck penetrations, watertight or fire doors.

3.2.5 Connection Equipment support and management arrangements are to be able to operate satisfactorily without damage during the Defined Operations.

3.2.6 Means are to be provided for Connection Equipment to be readily and safely adjusted in response to tidal changes, and other movements that could lead to damage or failure of connections, during the Defined Operations.

3.2.7 Connections with external electrical power supply arrangements are to be designed to separate (break away) at a tension higher than that required for normal operation but lower than the rating of the affected Connection Equipment to prevent damage to the ship structure or Connection Equipment, other than defined damage to break-away equipment (for example, shear bolts to be replaced). Evidence of compliance with this requirement is to be included in the submission required by 1.4.3.

3.2.8 Connection Equipment cable reels, cranes and/or gantries used to manage, handle or adjust connection cables, plugs and/or socket-outlets, are to be designed and manufactured in accordance with applicable LR Rules or a marine standard acceptable to LR. A manufacturer's certificate verifying suitability for safe and effective operation for the Defined Operations and service profile is to be submitted.

3.2.9 The manufacturer's certificate referred to in 3.2.8 is to be in the English language and include the following information:

(a) Design and manufacturing standard(s) used.
(b) Materials used for construction of key components and their sources.
(c) Details of the quality control system applied during design, manufacture and testing.
(d) Details of any existing type approval or type testing.
(e) Details of installation and testing recommendations.

The manufacturer is to have a recognised quality management system certified by an IACS member or a Notified Body.

3.2.10 Connection cubicle and connection equipment locations are to have warning notices placed in prominent positions to indicate the presence of moving equipment, electricity and high voltage as applicable.

3.2.11 Effective means are to be provided to prevent the accumulation of moisture and condensation within equipment enclosures.

3.2.12 Connection Equipment support and management arrangements are to ensure that the correctly applied equipment is kept clear of areas where they may be exposed to moisture or temperatures outside their rating.

3.2.13 Arrangements are to be provided for stowage of on-board equipment when not in use such that equipment:

- will not be exposed to environmental conditions outside its rating;
- can be stowed, stored and removed without damage; and
- does not present a hazard during normal ship operation.

Adapters, extensions and parts dismantled after use are also to be provided with stowage arrangements.

3.3 Connection cables, plugs and socket-outlets

3.3.1 Plugs and socket-outlets for external electrical power supply connection points, including those for external control engineering arrangements, are to be designed to avoid the possibility of incorrect connections being made.

3.3.2 Plugs are to conform to applicable requirements that ensure compatibility with the intended socket-outlet type.

3.3.3 Plugs and socket-outlets are to have provisions for connection to be made such that no strain is transmitted to the terminals and contacts. They are to be so designed such that when in place they will be held in positive contact and locked in position.

3.3.4 Plugs and socket-outlets are to be designed and constructed with the following sequence of connection and disconnection:

Connection

- earth contacts; then
- power contacts; then
- pilot contacts.

Disconnection

- pilot contacts; then
- power contacts; then
- earth contacts.

Pilot contacts refers to any auxiliary contacts used as part of the plug withdrawal detection required by 5.3.4.

3.3.5 Type tests are to be carried out on power connection plug and socket-outlets and cables, in accordance with appropriate standards, to verify design suitability for the intended application described in the Design Statement. Type test reports are to be submitted that include details of the standards, the tests conducted and their order and the acceptance criteria. Tests to be included are shown in Table 15.3.1 and 15.3.2. Alternative proposals may be submitted for consideration.

Table 15.3.1 Type tests for external power supply connection plugs and socket-outlets

Electrical tests
Partial discharge for high voltage ratings
High voltage
Short time and peak withstand current
Lightning impulse withstand
Withdrawal test to ensure a short-circuit arc cannot initiate in any position between complete insertion of the plug and the position at which withdrawal is detected, see also 5.3.4
Temperature rise
Mechanical tests
Shock and vibration
Enclosure degree of protection
Ageing of gaskets and insulators
Corrosion and resistance to rusting
Environmental tests in accordance with IEC 60092-101, Annex B and IEC 60721-3-6 for the ship environment following IEC TR 60721-4-6 for climatic and biological conditions and exposure to chemically and mechanically active substances and mechanical conditions
Normal operation test (at least 5000 cycles)
NOTES 1. After conducting the tests above, the temperature rise test, lightning impulse withstand test and high voltage test should be repeated. 2. Details of arc testing conducted in accordance with a relevant standard are to be submitted for consideration that verify that safety will be ensured in the intended connection location(s).

Table 15.3.2 Type tests for external power supply connection cables

Tests in accordance with Pt 6, Ch 2,10.2.2, as applicable
Partial discharge for high voltage ratings following bending tests
Resistance between protective conductors and semi-conductive layers where applicable
Solar radiation resistance
Abrasion resistance
Low temperature

3.3.6 High voltage cables, plugs and socket-outlets that also contain integral low voltage conductors (for example as part of the plug withdrawal detection required by 5.3.4) are to be of a construction and installed such that low voltage conductors are not subjected to high voltage, by physical connection or induction, under normal circumstances or in the event of a failure.

3.3.7 Power connection plugs and socket-outlets are to be assigned with the ratings for the characteristics shown in Table 15.3.3 based on testing, and details are to be provided in the submission required by 1.4.5. Plug and socket-outlets and cable ratings are to address the construction and cover the connections and cores as applicable, including control and auxiliary connections, and are to address the construction and material of the constituent components.

Table 15.3.3 External power supply connection plugs and socket-outlets ratings

Electrical characteristics
Nominal voltage
a.c. withstand voltage
Impulse a.c. withstand voltage
Partial discharge (for high-voltage equipment)
Nominal current
Short time short-circuit withstand capacity
Mechanical characteristics
Non-fixed plug or socket-outlet weight limit
Enclosure degree of protection
Acceptable cable cross-sectional area
Construction materials
Ambient temperature
Shock and vibration
Environmental category in accordance with IEC 60092-101, Annex B and IEC 60721-3-6

3.3.8 Connection Equipment cables are to be of a type, and installed in a manner such as to minimize the risk of short-circuit when correctly applied.

■ *Section 4* Electrical system

4.1 Electrical load transfer

4.1.1 'Dead transfer' arrangements are to be provided that permit transfer between operation using ship sources of electrical power and an external electrical power supply by disconnecting one from the ship distribution system and then connecting the other to the dead system.

4.1.2 Additional arrangements for connecting ship sources of electrical power and an external electrical power supply in parallel temporarily to transfer load from one to the other only are permitted, provided these are in accordance with 4.1.3 to 4.1.9.

4.1.3 Means to automatically synchronise a ship source of electrical power with an external electrical power supply and connect them in parallel for load transfer when requested by operating staff are to be provided.

4.1.4 Means to automatically transfer load between a ship source of electrical power and an external electrical power supply following their connection in parallel, are to be provided. The load transfer is to be completed in as short a time as practicable without causing machinery or equipment failure or operation of protective devices and this time is to be used as the basis for defining the Transfer Time Limit required by 4.1.5.

4.1.5 When transferring of load between ship sources of electrical power and an external electrical power supply exceeds a defined Transfer Time Limit then, arrangements are to be such that:

- the transfer is aborted;
- load is removed from the ship sources of electrical power or external electrical power supply that was intended to take the load; and then
- the Connection Circuit-Breaker is opened.

An alarm is to be provided at a machinery control station that is attended when connected to an external electrical power supply when the Transfer Time Limit is exceeded and is to indicate the return to previous operating conditions.

4.1.6 The Transfer Time Limit referred to in 4.1.5 may be adjustable to match the ability of an external electrical power supply to accept and shed load.

4.1.7 An external power supply may only be connected in parallel with a single ship source of electrical power. Arrangements are to be provided to ensure that this requirement is satisfied before and during parallel connection. Details of alternative proposals may be submitted for consideration.

4.1.8 Arrangements provided to adjust ship sources of electrical power to allow connection in parallel and transfer of load are not to cause machinery or equipment failure, operation of protective devices or damage under normal conditions or in the event of a failure.

4.1.9 Where load reductions are required to transfer load they are not to result in loss of essential services or the loss of availability of emergency services. Means are to be provided to readily make necessary load reductions and re-instate supplies following transfer.

4.2 Capacity

4.2.1 Arrangements for operating from external supplies are to be sufficiently rated to supply the following:

- essential services normally required in port;
- emergency services;
- services required to ensure ready availability of non-operating main and auxiliary machinery;
- services required to prevent damage to cargo or stores; and
- the services required for the Defined Operations.

The schedule of loads required by Pt 6, Ch 2,1.2.16 is to incorporate operation when connected to an external electrical power supply.

4.2.2 The maximum electrical step load switched on or off is not to cause the power supply quality to exceed the parameters given in Pt 6, Ch 2,1.7 or failure when connected to an external electrical power supply in accordance with the defined requirements, *see* 3.1.10.

4.2.3 Consideration is to be given to providing means to inhibit automatically the connection of large motors, or the connection of other large loads, that the arrangements are not rated to supply when connected to an external electrical power supply having the defined minimum apparent power or current capacity, *see* 3.1.10 and Pt 6, Ch 2,6.9.4.

4.3 Protection

4.3.1 Where an external electrical power supply is not arranged to operate in parallel with ship sources of electrical power, the connection to the external electrical power supply is to be provided with a Connection Circuit-Breaker arranged to open simultaneously, in the event of short-circuit, overload or undervoltage, all insulated poles.

4.3.2 Where an external electrical power supply is arranged to operate in parallel with ship sources of electrical power during load transfer, the connection to the external electrical power supply is to be provided with a Connection Circuit-Breaker arranged to open simultaneously, in the event of a short-circuit, an overload or an undervoltage, all insulated poles. This circuit-breaker is to be provided with reverse power protection with time delay, selected or set within the limits of 2 per cent to 15 per cent of full load to a value fixed in accordance with the rating defined in the Design Statement; a fall of 50 per cent in the applied voltage is not to render the reverse power mechanism inoperative, although it may alter the amount of reverse power required to open the circuit breaker.

4.3.3 The electrical system, including short-circuit protective device rating, is to be suitable for the highest prospective fault level at the point of installation. The short-circuit current calculations required by Pt 6, Ch 2,1.2.4 are to identify the system state that would result in the highest prospective fault level. The highest prospective fault level may occur during parallel connection with an external power supply and the resulting combination of:

(i) ship sources of electrical power, taking into account 4.1.7; and

(ii) an external electrical power supply having the defined maximum permitted prospective fault level, *see* 3.1.10.

Details of alternative proposals may be submitted for consideration.

4.3.4 The connection circuit is to be arranged such that contamination due to the products of arcing as a result of a fault in the Connection Circuit-Breaker enclosure on the external power supply side will not result in essential or emergency services not being available when supplied by ship sources of electrical power.

4.3.5 Initial connection of an external electrical power supply to the ship switchboards or converter equipment to connect to ship loads is to be arranged to be made by closing of the Connection Circuit-Breaker only.

4.3.6 Converter equipment used to connect an external electrical power supply to the ship electrical system is to ensure that a supply that would result in damage is not applied to the connected ship electrical systems in the event of a failure.

4.3.7 The voltage and time delay settings of the Connection Circuit-Breaker undervoltage release mechanism(s) are to be selected to ensure that the discriminative action required by Pt 6, Ch 2,6.1.1(a) is maintained.

4.3.8 Means are to be provided to prevent closure of the Connection Circuit-Breaker when a connected external electrical power supply has a different phase rotation or has a voltage or frequency that does not match the ship electrical system rating within the tolerances defined by Pt 6, Ch 2,1.7.2 or 1.7.4. Signals are to be provided, where necessary, to allow comparison with ship electrical system characteristics.

4.3.9 Connection power circuits are to be provided with protection against earth faults in accordance with Pt 6, Ch 2,6.4.

4.4 Interlocking and synchronising arrangements

4.4.1 External electrical power supply connections are to be provided with instruments and devices on board equivalent to those required for alternating current generators by Pt 6, Ch 2,7.11.1 where synchronising is not provided, or by Pt 6, Ch 2,7.11.2 to 7.11.3 where synchronising for load transfer is provided. *See also* Pt 6, Ch 2,7.11 and 7.12.

4.4.2 Means are to be provided to ensure that a source of electrical power or electrical power supply can only be connected to other live parts when synchronised. See also 4.1.2 for temporary parallel connection for load transfer.

4.4.3 The arrangements are to prevent Connection Equipment power conductors being made live by connecting to the ship electrical system.

4.4.4 The simultaneous connection of a ship source of electrical power and external electrical power supply to the same dead part of the electrical system is to be prevented.

4.4.5 For high-voltage connections, suitable means are to be provided to earth the connection power circuit so that it is discharged and so maintained that it is safe to touch.

4.4.6 Means provided to connect a connection power circuit to earth are to be arranged such that the circuit may only be earthed when it is isolated.

4.4.7 Interlocking arrangements are to be provided to prevent the connection of a high-voltage external power supply to a switchboard connected to earth using the means required by Pt 6, Ch 2,7.8.

4.5 Ship power restoration

4.5.1 When the ship main source of electrical power is shut-down and failure of the connected external electrical power supply occurs, the Connection Circuit-Breaker is to be arranged to automatically open followed by:

(a) connection of the emergency source of electrical power to emergency services in accordance with Pt 6, Ch 2,3.2.6(a)(ii), 3.2.6(b)(ii) to (iii), 3.3.6(a)(ii) or 3.3.6(b)(ii) to (iii) as applicable; and

(b) automatic connection of the transitional source of electrical power to emergency services in accordance with Pt 6, Ch 2,3.2.7 or 3.3.7 as applicable; and

(c) automatic starting and connecting to the main switchboard of the main source of electrical power and automatic sequential restarting of essential services, in as short a time as is practicable. *See also* 2.1.3 and Pt 6, Ch 2,2.2.3.

Failures include loss of power, disconnection, phase failure and quality of supply outside the tolerances given in Pt 6, Ch 2,1.7.2 or 1.7.4.

4.5.2 An alarm is to be provided at a machinery control station that is attended when connected to an external electrical power supply to indicate activation of the automatic power supply failure response required by 4.5.1. The alarm is to indicate the failure that caused the activation.

4.5.3 The automatic power supply failure response required by 4.5.1 is to be inhibited during the 'dead transfer' required by 4.1.1 but arrangements are to permit personnel to readily revert to operation from ship sources of electrical power if the 'dead transfer' to the external electrical power supply is not completed.

■ *Section 5* Control and monitoring

5.1 General

5.1.1 Control engineering arrangements are to be in accordance with Pt 6, Ch 1, as applicable. The connection of, and the electrical load transfer to and from, an external electrical power supply are only to be controlled on board using shipboard arrangements.

5.1.2 External control of ship equipment may only be provided when in accordance with 5.1.5. Otherwise, external arrangements may be used to send requests for action to ship personnel for consideration.

5.1.3 Integration or connection with external, control, alarm and safety systems is to be 'fail-safe'.

5.1.4 The effects of failure of control, alarm and safety system and data communication link connections are to be documented along with resulting failure responses in the submission required by 1.4.6.

5.1.5 Details of proposals that would involve external control of ship equipment to respond to potentially hazardous situations detected externally are to be submitted for consideration. Provided that the arrangements are considered to be in accordance with the provisions of an acceptable and relevant standard, the following external control functions may be permitted:

- initiation of load reductions;
- initiation of electrical load transfer to ship sources of electrical power; and
- initiation of Emergency Shut-Down.

5.1.6 The connection power circuit is to be isolated, and for high-voltage connections connected to earth so that it is discharged and so maintained that it is safe to touch, until the connections necessary for safe and effective operation are correctly established, including control, alarm and safety system and data communication link connections.

5.1.7 Following the correct establishment of the necessary connections in accordance with 5.1.6:

- where applicable, the connection power circuit may be disconnected from earth; and arranged such that only then
- may the request to make the external power supply connection points live described in 5.1.8 be sent.

5.1.8 Ship control system arrangements are to be provided to request the external electrical power supply conductors to be:

- where applicable, disconnected from earth; and then
- made live up to the connection points.

5.1.9 An alarm is to be provided at a machinery control station that is attended when connected to an external electrical power supply upon failure of arrangements required to maintain ready availability in accordance with 2.1.3 (for example pre-heating).

5.1.10 Additional alarms with their associated safeguards are indicated in Table 15.5.1. These are in addition to those required by other Parts of the Rules.

5.1.11 Means are to be provided to allow testing of control, alarm and safety system connections with external arrangements, including operation of Emergency Shut-Down facilities, before electrical connection to an external power supply.

5.2 Connection Equipment control and monitoring

5.2.1 Connection Equipment is to be capable of unattended operation under normal operating conditions after correct application of the connection. Remote indication of active ship equipment faults at a machinery control station that is attended when connected to an external electrical power supply is to be provided. Details of arrangements that involve periodic attendance to inspect and adjust Connection Equipment may be submitted for consideration.

5.2.2 A control station is to be provided locally to Connection Equipment cable reel, cranes and gantries that permits identification of faults and permits safe and effective supervision and control of this equipment in the foreseeable environmental conditions.

5.2.3 A fixed means of two-way voice communication with a machinery control station that is attended when connected to an external electrical power supply is to be provided at the control station required by 5.2.2.

Table 15.5.1 Additional alarms and associated safeguards

Item	Alarm	Note
Presence of voltage on connections		Indicators in accordance with 3.1.9.
Transfer of load	Time limit exceeded	Return to previous operating state to be indicated, *see* 4.1.5.
Ship power restoration	Activation	*See* 4.5.2.
Arrangements to ensure main and auxiliary machinery availability	Failure	When shut-down. *See* 5.1.9.
Applied connection equipment status	Changed	Indication to be provided also. *See* 5.2.4 and 5.2.5.
Connection equipment	Close proximity to water level	*See* 5.2.6.
Connection equipment tension	High	Emergency shut-down to be activated. *See* 5.3.7.
Plug connectors	Withdrawal	
Connection cable, for connection ratings	Short-circuit	
Manual disconnection	Activation	

5.2.4 The control station required by 5.2.2 is to be provided with a means for operators to:
- select manual control; or
- lock equipment in position; or
- where provided, select automatic adjustment.

This status is to be indicated remotely at a machinery control station that is attended when connected to an external electrical power supply.

5.2.5 When the equipment status selection referred to in 5.2.4 is changed whilst an external electrical power supply is connected, an alarm is to be activated at a machinery control station that is attended when connected to an external electrical power supply.

5.2.6 An alarm is to be provided at a machinery control station that is attended when connected to an external electrical power supply when Connection Equipment approaches a situation where it may be submerged in the water between the ship and shore, for instance due to tidal changes. The time between alarm initiation and possible exposure to this water is to be sufficient to allow the equipment to be attended and adjusted prior to exposure to water. Where alternative equivalent arrangements are proposed (for example, submersible equipment, equipment routing or slack cable prevention by torque control), details are to be submitted for consideration.

5.3 Emergency Shut-Down

5.3.1 The requirements of this sub-Section apply to arrangements for the emergency disconnection of live electrical power from the connection to an external electrical power supply.

5.3.2 Emergency Shut-Down facilities are to be provided that, when activated, will instantaneously:
- isolate the connection from ship electrical power supplies; and
- request isolation of the external electrical power supply connection points.

For high-voltage connections, the Connection Equipment power connections are to be discharged so that they are safe to touch following isolation from ship and shore electrical power supplies before power conductors are exposed.

5.3.3 Means to detect or predict tension in the external electrical power supply connection cable are to be provided and before damage occurs, these arrangements are to activate the Emergency Shut-Down facilities described in 5.3.2. Where alternative arrangements to tension detection are proposed (automatic break-away release, connectors with shear bolts and pilot lines, connection with ship/shore Emergency Shut-Down system, etc.), details are to be submitted for consideration.

5.3.4 To prevent the withdrawal of plugs from socket-outlets while power supply connections are live, the Emergency Shut-Down facilities described in 5.3.2 are to be activated before the necessary degree of protection is no longer achieved or power connections are broken by the removal of a plug from a connected socket-outlet, including in-line connections.

5.3.5 Where shipboard cables are extended to the external electrical power supply connection points then a protective device is to be provided which will activate the Emergency Shut-Down facilities described in 5.3.2 in the event of a short-circuit in the shipboard cables from the connection cubicle when connected to an external power supply in accordance with 3.1.10.

5.3.6 Means to manually activate the Emergency Shut-Down facilities described in 5.3.2 are to be provided at:
- a machinery control station that is attended when connected to an external electrical power supply;
- in close proximity to the connection cubicle; and
- at the switchboard where the fixed cable from the shore connection cubicle are received.

Additional manual activation facilities may also be provided at other locations where it is considered necessary. The means of activation are to be visible and prominent, prevent inadvertent operation and require a manual action to reset.

5.3.7 An alarm to indicate activation of the Emergency Shut-Down is to be provided at a machinery control station that is attended when connected to an external electrical power supply. The alarm is to indicate the cause of the activation. For power supply restoration, *see* 4.5.1 to 4.5.3.

■ *Section 6*
Testing, trials and surveys

6.1 General

6.1.1 The testing and trials required by 6.1.2 to 6.1.4 are to be successfully completed to the Surveyor's satisfaction before **OPS** notation may be assigned. Where appropriate test facilities cannot be provided, trials are likely to require the additional co-operation of a port facility with a suitable external electrical power supply and the ability to operate the defined services to be supplied during these trials and allow the testing described to be conducted.

6.1.2 Electrical and control engineering equipment is to be surveyed at manufacturer's works and undergo survey and operational trials on board in accordance with the approved test schedules and applicable testing requirements in Pt 6, Ch 1 and Ch 2. *See also* Pt 6, Ch 2,1.3.5.

6.1.3 Cable reels, cranes and/or gantry drives for Connection Equipment are to be surveyed and tested in accordance with applicable LR Rules and 3.2.9(e).

6.1.4 Trials are to be conducted when connected to a compatible external electrical power supply in accordance with 3.1.10 to demonstrate to the attending Surveyor that the Rules have been complied with in respect of:

(a) operation of connection management arrangements;
(b) trials on cable lifting appliances (for example cable reels or cranes) are to be conducted that demonstrate suitability for the maximum mechanical load and duty required by the Defined Operations within the service profile contained in the Design Statement, including connection of extensions or adapters;
(c) satisfactory performance of the connection and Connection Equipment throughout the Defined Operations, including a run with the defined services to be supplied operational;
(d) temperature of electrical joints, connections, circuit-breakers and fuses;
(e) the operation of electrical load transfer arrangements, electrical system protection and interlocking devices, Emergency Shut-Down arrangements and other safety devices and ship power restoration;
(f) where acceptable type-test evidence is not submitted, connection break-away, *see* 3.2.7;
(g) voltage regulation when the maximum load is suddenly thrown off and when starting the largest motor connected to the system;
(h) where more than one external power supply connection can be operated in parallel, satisfactory load sharing at loads up to normal working load; and
(j) voltage drop is to be measured, where necessary, to verify that this is not in excess of that specified in Pt 6, Ch 2,1.7.

6.1.5 Arrangements are to be:

- examined at Annual Survey; and
- examined and functionally tested within Special Survey cycles whilst connected to an external electrical power supply.

This is to include examination of Connection Equipment.

Part 7, Chapter 16

Requirements for Machinery and Engineering Systems of Unconventional Design

Effective date 1 July 2008

■ *Section 1* Requirements for machinery and engineering systems of unconventional design

1.1 General - Scope and objectives

1.1.1 Consistent with the aims of the IMO guidelines for Formal Safety Assessment (MSC/Circ.1023), the requirements of this Section aim to ensure that risks to maritime safety and the environment, stemming from the introduction of machinery or engineering systems of unconventional design, are addressed insofar as they affect the objectives of classification.

1.1.2 The requirements of this section are to be satisfied where:

(a) machinery is required to be constructed, installed and tested in accordance with Lloyds Register's (herein after referred to as LR) Rules and Regulations and for which the corresponding machinery class notation is to be assigned (see Part 1, Ch 2.2.4), and,

(b) the machinery and engineering systems are considered by LR to be of an unconventional design and which, as a result, are not directly addressed by LR's extant Rules and Regulations.

1.1.3 It is to be noted that as well as the requirements of this section, the general requirements of LR's Rules and Regulations are also to be satisfied as far as they are applicable.

1.1.4 Compliance with ISO15288 Systems Engineering - System Life Cycle Processes or an acceptable equivalent national standard may be accepted as meeting the requirements of 1.3 to 1.11.

1.2 Information to be submitted

1.2.1 Information is to be submitted for assessment of compliance with the general requirements of LR's Rules and Regulations, including the general requirements for:

(a) Machinery (*see* Pt 5, Ch 1).

(b) Steam raising plant and pressure vessels (*see* Pt 5, Ch 10).

(c) Machinery and ship piping systems (see Pt 5, Ch12 to Ch 14).

(d) Control engineering (*see* Pt 6, Ch 1).

(e) Electrical engineering (*see* Pt 6, Ch 2).

(f) Materials (*see Rules for the Manufacture, Testing and Certification of Materials*).

1.2.2 In addition to the information identified in 1.2.1, the information described in 1.2.3 and 1.2.4 is also to be submitted for consideration.

1.2.3 General description detailing the extent of the machinery or engineering system, the shipboard services it is to provide, its operating principles, and its functionality and capability when operating in the environment to which it is likely to be exposed under both normal and foreseeable abnormal conditions. The general description is to be supported by the following information as applicable:

(a) System block diagram.

(b) Piping and instrumentation diagrams.

(c) Description of operating modes, including:
Start-up, shut-down, automatic, reversionary, manual and emergency.

(d) Description of safety related arrangements, including:
Safeguards, automatic safety systems and interfaces with ships safety systems.

(e) Description of connections to other shipboard machinery, equipment and systems, including:
Electrical, mechanical, fluids and automation.

(f) Plans of physical arrangements, including:
Location, operational access and maintenance access.

(g) Operating manuals, including:
Instructions for start-up, operation, shut-down, instructions for maintenance, instructions for adjustments to the performance and functionality and details of risk mitigation arrangements.

(h) Maintenance manuals, including:
Instructions for routine maintenance, repair following failure, disposal of components and recommended spares inventory.

1.2.4 Project process documentation including:

(a) Project Management Plan (*see* 1.3).

(b) Requirements Definition Document (*see* 1.4).

(c) Quality Assurance Plan (*see* 1.5).

(d) Design Definition Document (*see* 1.6).

(e) Risk Management Plan (*see* 1.7).

(f) Configuration Management Plan (*see* 1.8).

(g) Verification Plan (*see* 1.7).

(h) Integration Plan (*see* 1.10).

(j) Validation Plan (certification and survey) (*see* 1.11).

1.3 Project management

1.3.1 A project management procedure is to be established in order to define and manage the key project processes. The project processes are to include the processes described in 1.4 to 1.11.

1.3.2 For the entire project, and each of the processes within the project, the project management procedure is to define the following:

(a) Activities to be carried out.

(b) Required inputs and outputs.

(c) Roles of key personnel.

(d) Responsibilities of key personnel.

(e) Competence of key personnel.

(f) Schedules for the activities.

1.4 Requirements definition

1.4.1 A requirements definition procedure is to be established in order to define the functional behaviour and performance of the machinery or engineering system required by individual stakeholders, in the environments to which the machinery or engineering system is likely to be exposed under both normal and foreseeable emergency conditions.

1.4.2 The procedure is to take account of requirements resulting from key stakeholders, including:
(a) Ship's owner.
(b) Ship's operator.
(c) Ship's crew.
(d) Shipyard.
(e) Systems integrator.
(f) Designers.
(g) Maintenance personnel
(h) Surveyors
(j) Manufacturers and suppliers.
(k) National Administration.
(l) LR.

1.4.3 The procedure is to take account of requirements resulting from the following influences:
(a) Ship operations, including:
Underway, manoeuvring, pilotage, docking, alongside and training exercises.
(b) Ship conditions, including:
Normal operation, abnormal operation, blackout, deadship, fire in a single compartment and flooding of a single compartment.
(c) Environmental conditions, including:
Temperature, humidity, water spray, salt mist, vibration, shock, inclination, electrical fields and magnetic fields.
(d) Applicable provisions, including:
Statutory legislation, classification requirements, international standards, national standards and codes of practice.
(e) Expected users, including:
Multi-national users with a range of national languages and cultures, fatigued users, users without dedicated training, and maintenance and survey personnel.
(f) Design, construction and operational constraints, including:
Effect of particular design decisions or component choices on other aspects of design, risk and production engineering compromises, verification, integration and validation considerations, maintenance and disposal, and changes in use.

1.4.4 The procedure is to specify the functional behaviour and performance requirements and is to identify the source of the requirements.

1.5 Quality assurance

1.5.1 A quality assurance procedure is to be established in order to ensure that the quality of the machinery or engineering system is in accordance with a defined quality management system.

1.5.2 The procedure is to define the specific quality controls to be applied during the project in order to satisfy the requirements of the quality management system.

1.5.3 The quality management system is to satisfy the requirements of ISO9001:2000 Quality management systems – Requirements, or an equivalent acceptable national standard.

1.6 Design definition

1.6.1 A design definition procedure is to be established in order to define the requirements for the design of machinery or an engineering system which satisfies stakeholder requirements, quality assurance requirements and complies with basic internationally recognised design requirements for safety and functionality.

1.6.2 The procedure is to ensure that the design of the machinery or engineering system satisfies:
(a) Statutory legislation.
(b) LR's requirements.
(c) International standards and codes of practice where relevant.

1.6.3 The procedure is to take account of stakeholder requirements, *see* 1.4.

1.6.4 The procedure is to take account of quality assurance requirements, *see* 1.5.

1.6.5 The procedure is to ensure that the requirements for the design of major components and subsystems of the machinery or engineering system can be verified before and after integration.

1.6.6 The procedure is to specify the design requirements and is to identify the source of the requirements.

1.6.7 Any deviations from stakeholder requirements are to be identified, justified and accepted by the originating stakeholder.

1.7 Risk management

1.7.1 A risk management procedure is to be established in order to ensure that any risks stemming from the introduction of the machinery or engineering system are addressed, in particular risks affecting:
(a) The structural strength and integrity of the ship's hull.
(b) The safety of shipboard machinery and engineering systems.
(c) The safety of shipboard personnel.
(d) The reliability of essential and emergency machinery and engineering systems.
(e) The environment.

1.7.2 The procedure is to consider the hazards associated with installation, operation, maintenance and disposal, both with the machinery or engineering system functioning correctly and following any reasonably foreseeable failure.

1.7.3 The procedure is to take account of stakeholder requirements, *see* 1.4.

1.7.4 The procedure is to take account of design requirements, *see* 1.6.

1.7.5 The procedure is to ensure that hazards are identified using acceptable and recognised hazard identification techniques, and that the effects of the following influences are considered:

(a) Ship operations, including:
Underway, manoeuvring, pilotage, docking, alongside and maintenance, commissioning and trials.
(b) Ship conditions, including:
Normal operation, blackout, dead-ship, fire in a single compartment and flooding of a single compartment.
(c) Modes of operation, including:
Start-up, running, shut-down, automatic, reversionary, manual and emergency.
(d) Environmental conditions, including:
Temperature, humidity, water spray, salt mist, vibration, shock, inclination, electrical fields and magnetic fields.
(e) Dependencies, including:
Power, fuel, air, cooling, heating, data and human input.
(f) Environmental impact, including:
Emissions to air, discharges to water, noise and waste products.
(g) Failures, including:
Human error, supply failure, system, machinery, equipment and component failure, random, systematic and common cause failures.

1.7.6 The procedure is to ensure that risks are analysed using acceptable and recognised risk analysis techniques and that the following effects are considered:

(a) Local effects:
Loss of function, component damage, fire, explosion, electric shock, harmful releases and hazardous releases.
(b) End effects on:
Services essential to the safety of the ship, services essential to the safety of shipboard personnel and services essential to the protection of the environment.

1.7.7 The procedure is to ensure that risks are eliminated wherever possible. Risks which cannot be eliminated are to be mitigated as necessary.

1.7.8 Details of risks, and the means by which they are mitigated, are to be included in the operating manual, *see* 1.2.3.

1.8 Configuration management

1.8.1 A configuration management procedure is to be established in order to ensure traceability of the configuration of the machinery or engineering system, its subsystems and its components.

1.8.2 The procedure is to identify items essential for the safety or operation of the machinery or engineering system (configuration control items) which could foreseeably be changed during the lifetime of the machinery or engineering system, including:

(a) Documentation.
(b) Software.
(c) Sensors.
(d) Actuators.
(e) Instrumentation.
(f) Valves.
(g) Pumps.

1.8.3 The procedure is to take account of the design requirements (*see* 1.6).

1.8.4 The procedure is to include items used to mitigate risks (*see* 1.7).

1.8.5 The procedure is to ensure that any changes to configuration control items are:

(a) Identified.
(b) Recorded.
(c) Evaluated.
(d) Approved.
(e) Incorporated.
(f) Verified.

1.9 Verification

1.9.1 A verification procedure is to be established in order to ensure that subsystems and major components of the machinery or engineering system satisfy their design requirements.

1.9.2 The procedure is to verify design requirements, *see* 1.6.

1.9.3 The procedure is to identify the requirements to be verified, the means by which they are to be verified, and the points in the project at which verification is to be carried out.

1.9.4 The procedure is to be based on one or a combination of the following activities as appropriate:

(a) Design review.
(b) Product inspection.
(c) Process audit.
(d) Product testing.

1.10 Integration

1.10.1 An integration procedure is to be established in order to ensure that the machinery or engineering system is assembled in a sequence which allows verification of individual subsystems and major components following integration in advance of validating the entire machinery or engineering system.

1.10.2 The procedure is to take account of the verification requirements, *see* 1.9.

1.10.3 The procedure is to identify the subsystems and major components, the sequence in which they are to be integrated, the points in the project at which integration is to be carried out, and the points in the project at which verification is to be carried out.

1.11 Validation (certification and survey)

1.11.1 A validation procedure is to be established in order to ensure the functional behaviour and performance of the machinery or engineering system meets with its functional and performance requirements.

1.11.2 The procedure is to validate stakeholder requirements, *see* 1.4.

1.11.3 The procedure is to validate arrangements required to mitigate risks, *see* 1.7.

1.11.4 The procedure is to validate the traceability of the configuration control items, *see* 1.8.

1.11.5 The procedure is to identify the requirements to be validated, the means by which they are be validated and the points in the project at which validation is to be carried out, including:

(a) Factory acceptance testing.
(b) Integration testing.
(c) Commissioning.
(d) Sea trials.
(e) Survey.

Cross-references

Section numbering in brackets reflects any Section re-numbering necessitated by any of the Notices that update the current version of the Rules for Ships.

Part 1, Chapter 2

3.5.25 Reference to Ch 3,2.2.19 *now reads* Ch 3,2.2.20

Part 1, Chapter 3

2.2.28(b) Reference to Table 3.6.4 *now reads* Table 3.6.5.
Reference to Table 3.6.5 *now reads* Table 3.6.6.
Reference to Table 3.6.6 *now reads* Table 3.6.7.
Reference to Table 3.6.7 *now reads* Table 3.6.8.
Reference to Table 3.6.8 *now reads* Table 3.6.9.
Reference to Table 3.6.9 *now reads* Table 3.6.10.

Table 3.2.1 Reference to Table 3.6.4 *now reads* Table 3.6.5.
Reference to Table 3.6.5 *now reads* Table 3.6.6.
Reference to Table 3.6.6 *now reads* Table 3.6.7.
Reference to Table 3.6.7 *now reads* Table 3.6.8.
Reference to Table 3.6.8 *now reads* Table 3.6.9.
Reference to Table 3.6.9 *now reads* Table 3.6.10.

3.2.14(b) Reference to Table 3.6.3 *now reads* Table 3.6.4.
Reference to Table 3.6.4 *now reads* Table 3.6.5.
Reference to Table 3.6.5 *now reads* Table 3.6.6.
Reference to Table 3.6.6 *now reads* Table 3.6.7

Table 3.3.1 Reference to Table 3.6.4 *now reads* Table 3.6.5.
Reference to Table 3.6.5 *now reads* Table 3.6.6.
Reference to Table 3.6.6 *now reads* Table 3.6.7.
Reference to Table 3.6.7 *now reads* Table 3.6.8.
Reference to Table 3.6.8 *now reads* Table 3.6.9.
Reference to Table 3.6.9 *now reads* Table 3.6.10.

6.7.2 Reference to Table 3.6.5 *now reads* Table 3.6.6.
Reference to Table 3.6.6 *now reads* Table 3.6.7.
Reference to Table 3.6.7 *now reads* Table 3.6.8.

Part 5, Chapter 2

15.2.1(c) Reference to 13.5 *now reads* 15.5

Part 5, Chapter 10

15.2.1 Reference to 15.2.11 *now reads* 15.2.13.

15.2.7 Reference to 15.2.11 *now reads* 15.2.13.

15.3.1 Reference to 15.2.11 *now reads* 15.2.13.

Part 7, Chapter 12

4.1.3 Reference to Pt 6, Ch 2,3.2.7 *now reads* Pt 6, Ch 2,3.2.9
Reference to Pt 6, Ch 2,3.3.7 *now reads* Pt 6, Ch 2,3.3.9

CORRIGENDA

Part 1, Chapter 3

Existing paragraphs 2.2.20 *to* 2.2.36 *are to be renumbered* 2.2.23 *to* 2.2.39.

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